VOLUME 18 NUMBER 4

ARCHIVES OF NEUROLOGY AND PSYCHIATRY

OCTOBER, 1927

PUBLISHED MONTHLY BY AMERICAN MEDICAL ASSOCIATION, 535 NORTH DEARBORN STREET, CHICAGO, ILLINOIS. ANNUAL SUBSCRIPTION, $8.00

Entered as Second-Class Matter, Jan. 7, 1919, at the Postoffice at Chicago, Illinois, Under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in Section 1103, Act of Oct. 3, 1917, authorized Jan. 15, 1919.

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Archives of Neurology and Psychiatry

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THE CORPUS STRIATUM

A STUDY OF SECONDARY DEGENERATIONS FOLLOWING LESIONS IN MAN AND OF SYMPTOMS AND ACUTE DEGENERATIONS FOLLOWING EXPERIMENTAL LESIONS IN CATS*

LAWRENCE ONIS MORGAN, Ph.D.

CHICAGO

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INTRODUCTION

As early as 1667, Willis described the corpus striatum as "internodes by which the cerebrum coheres with the medulla oblongata." A long period followed in which frequent attempts were made to understand the nature and function of this body. In many of these attempts the results were entirely negative, while the positive results obtained were so conflicting that the corpus striatum continued to be one of the greatest mysteries of the nervous system.

The subject took on new interest in the early part of the twentieth century when C. and O. Vogt,[1] Wilson [2] and others set forth definite

*From the Department of Anatomy, Cornell University Medical College, Ithaca, New York.

* The expenses of this investigation were met by a grant from the Sarah Manning Sage Research Fund.

1. Vogt, C.: Quelques considérations générales à propos du syndrome du corps strié, J. f. Psychol. u. Neurol. **18**:479, 1911. Vogt, C., and Vogt, O.: Zur Kenntnis der pathologischen Veränderungen des Striatum und des Pallidum und zur Pathophysiologie der dabei auftretenden Krankheitserscheinungen, Sitzungsb. d. Heidelberger Akad. d. Wissensch., part b, Abhandlung., 1919, no. 14.

2. Wilson, S. A. K.: Progressive Lenticular Degeneration: A Familial Disease Associated with Cirrhosis of the Liver, Brain **34**:295, 1912.

clinical syndromes for diseases of the corpus striatum. In recent years, much has been added to the knowledge of the anatomy, pathology and physiology of this important body. Most of this knowledge has come from clinical sources.

There still remains much to be learned about the exact fiber connections and functions of the corpus striatum. This is also true concerning the nature of the disturbances following pathologic changes in this body. It is well known that there are nearly always marked disturbances of speech, mastication and deglutition accompanying injury or disease of the corpus striatum. I have been able in this investigation to demonstrate a definite system of neurons through which these functional defects are brought about. Likewise, there are well pronounced motor disturbances which regularly accompany diseases of the corpus striatum, but the present knowledge of the nature and anatomic basis for these disturbances leaves much to be desired. The striorubral fasciculus of Wilson is accepted by many authorities as one of the most important efferent connections of the corpus striatum, and some of the most severe symptoms accompanying degeneration in the corpus striatum have been ascribed to this connection. The present investigation has forced me to the conclusion that the striorubral fasciculus is perhaps the least of the numerous efferent connections of the corpus striatum. An attempt has been made as far as possible to locate the specific terminations of the efferent striate fibers, not only as to the region of termination but also as to the definite cell masses which the fibers terminate.

A definite symptomatology has consistently accompanied lesions placed in the lenticular nucleus of experimental animals. This symptomatology has to a striking degree resembled, in many respects, the clinical syndromes described for the corpus striatum.

By making use of both experimental animal material and pathologic human material, an attempt has been made to eliminate some of the discrepancies existing between the results of the clinical and experimental investigations.

MATERIALS AND METHODS

This problem was first undertaken with a study of six human brains with lesions in the corpus striatum. These brains were photographed and carefully studied in the gross. The brain stems were then embedded in celloidin, and sections 50 microns thick were stained, some with iron alum hematoxylin and others with iron alum hematoxylin and neutral red, according to the methods I described in a previous paper.[3] The pathologic condition of much of this material was such that it yielded

3. Morgan, L. O.: Iron Hematoxylin as a Myelin-Sheath Stain and Neutral Red Ripened by Colon Bacillus as a Nerve-Cell Stain, Anat. Rec. **32**:283, 1926.

little evidence on the fiber connections of the corpus striatum, and also did not yield as much information as was hoped for along other lines. Only two of these brains have been described in the present paper, although the remainder have been studied so far as they yielded evidence on any of the points discussed. It was found advisable, however, to supplement this material by experimental work on mammals.

The cat was chosen for this experimental study. All attempts to place bilateral lesions in the corpus striatum resulted in the death of the animal. In the material to be considered, a lesion was placed in the lenticular nucleus of the left side. About fifty animals were utilized in this experiment. In more than forty of these, the lesion was placed in the lenticular nucleus, while in the remainder, portions of the cerebral cortex were extirpated for the purpose of eliminating cortical symptoms and the degeneration of cortical fibers. From eight to eleven days after the operation, the animals were killed (gassed) and the brain and upper cervical cord were hardened in formaldehyde. Parts of the brain, in most cases including the medulla, pons, midbrain, thalamus and corpus striatum, were then treated by the Marchi method for degenerated nerve fibers, embedded in celloidin and sections 30 microns thick were made. Of the forty cats in which the lesion was placed in the corpus striatum, the fifteen best specimens were chosen for study. Six of these have been described in this paper. The brain of one animal in which the frontal cortex was extirpated and another in which a large part of the parietal cortex was extirpated were prepared for microscopic study.

The operative approach was through the left temporal region. Incision was made through the skin over the temporalis muscle; the aponeurosis from which the muscle takes origin was cut over the dorsocephalic part, and the muscle was turned caudally with as little injury as possible. A small opening was then made through the bone with a dental drill at a point calculated to lie over the anterior rhinal sulcus. A probe with a small somewhat curved blade was inserted through the dura so that it would pass through the anterior rhinal sulcus and reach various parts of the lenticular nucleus. A large destructive lesion was then made in that area. The temporalis muscle was put back in its normal position, and stitches were taken in the aponeurosis. The skin and deep fascia were also sutured and the wound sealed over with celloidin. In some cases intracranial hemorrhage occurred, which affected the animal more or less for a brief period following the operation.

It was hoped that, by making a large lesion of the corpus striatum pronounced symptoms could be obtained. At the same time the fiber systems would be largely degenerated, so that their size and termination could be more easily ascertained.

DESCRIPTION OF CASES

BRAINS OF ANIMALS

Cat 444.—A lesion was made in the corpus striatum of the left side. The animal was killed after eight days.

Symptoms.—Immediately after the operation, the cat exhibited circus movements to the right and a coarse tremor affecting especially the head and neck. These symptoms disappeared within an hour.

After two or three days, when the animal had recovered from the immediate effects of the operation, it became restless, irritable and hypertonic. It remained almost constantly in motion without any apparent purpose, sometimes walking or running about, at other times standing and alternately raising one front foot and then the other in a manner resembling athetosis. It walked in a tense, somewhat spastic manner. Frequently it walked in a small circle to the left, sometimes making several rotations in rapid succession. The body was always bent convexly to the left during these circus movements and showed a slight tendency to be somewhat curved to the left at all times. The animal was unable to turn to the right. When food was presented or when it was disturbed in any way, the hypertonic condition was increased and the circus movements became more frequent and more prolonged. Both of these conditions were associated with hypertonicity of the muscles of the body, which was much more pronounced on the left side. The animal had good use of all limbs. The leg retraction reflexes were good on the left side but were exaggerated on the right. The skin reflexes were weak on the left side of the face. The eyes shifted constantly in a restless, nervous manner. The left pupil was about a third smaller than the right.

After eight days the hypertonic condition subsided, the circus movements ceased and the animal became normal to all appearances. The left pupil, however, remained smaller. The animal lapped milk but did not attempt to take any solid bits of food into the mouth. It swallowed well. When it attempted to meow, no sound was emitted.

Respirations were 36 a minute; the temperature was 102, and the rate of heart beat, 78.

Lesion.—The lesion was fairly large, involving the lenticular nucleus in its caudal half. It penetrated the lateral portion of the putamen in its ventral part and at a point about midway between the cephalic and caudal ends of the nucleus. It was directed caudad and mediad, destroying the ventral half of the putamen and of the lateral segment of the globus pallidus (plate 1, fig. 1). A small lesion extended into the medial division of the globus pallidus, destroying about one third of that division. A limb of the lesion extended ventrad into the region occupied by the amygdaloid nucleus. The external capsule was injured in its ventral portion over an area about 2 mm. in diameter. There was also slight injury to the most ventral fibers of the internal capsule adjacent to the globus pallidus. More caudad, the optic tract was partially cut.

Degenerations.—1. A great number of fine degenerated fibers arose from the medial division of the globus pallidus and the ventral portion of the lateral division at the caudal level of the nucleus. Many of these fibers passed mediad to the ventromedial portion of the internal capsule, while others took a more lateral position and passed in an oblique, dorsocaudal direction through the internal capsule. They did not form well defined fasciculi, but passed as diffusely scattered fibers running separately or in minute bundles, forming a broad field of fine degeneration. This group of fibers passed through, and mediad

to the internal capsule cephalad to the level of the subthalamic nucleus of Luys and will be further considered under two divisions: (*a*) From 4,500 to 5,000 fine degenerated fibers, passed directly through the zona incerta and turned caudad in the cephalic part of a broad field which was designated by Winkler and Potter as the nucleus hypothalamicus lateralis (*h.b.*) and by Malone as the substantia reticularis hypothalami (Cajal's nucleus interstitialis of Forel's

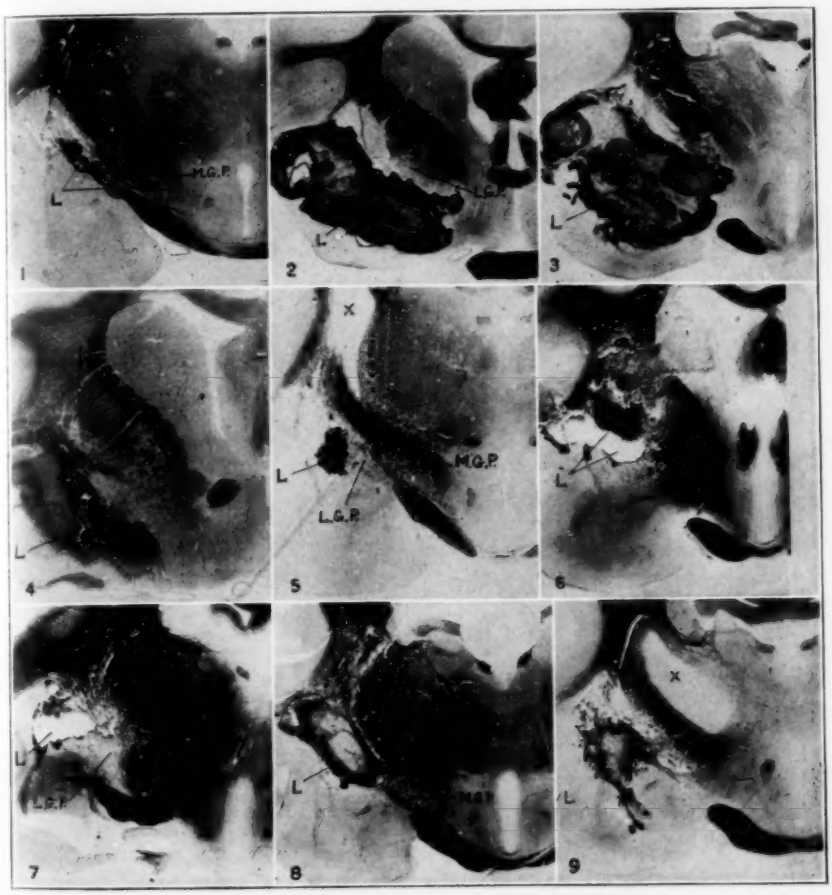

Plate 1—Cross-sections through the brains of cats to show the location of lesions in the corpus striatum. Fig. 1 shows the section from cat 444; figs. 2 and 3, from cat 471; figs. 4 and 5, cat 448; figs. 6 and 7, cat 445; fig. 8, cat 434 and fig. 9, cat 420. *L* indicates the lesion; *M. G. P.*, medial division of the globus pallidus; *L. G. P.*, lateral division of the globus pallidus, and *X*, the unstained area.

field, Vogt's nucleus campi Foreli [plate 4, fig. 1]); (*b*) from 4,000 to 4,500 degenerated fibers, coarser in structure than the preceding group, passed obliquely through the medial third of the internal capsule and turned mediad into Forel's field H_2 (plate 4, fig. 1). Some terminate on cells scattered through the medial part of that field (Cajal's nucleus of the internal capsule?). A small band of

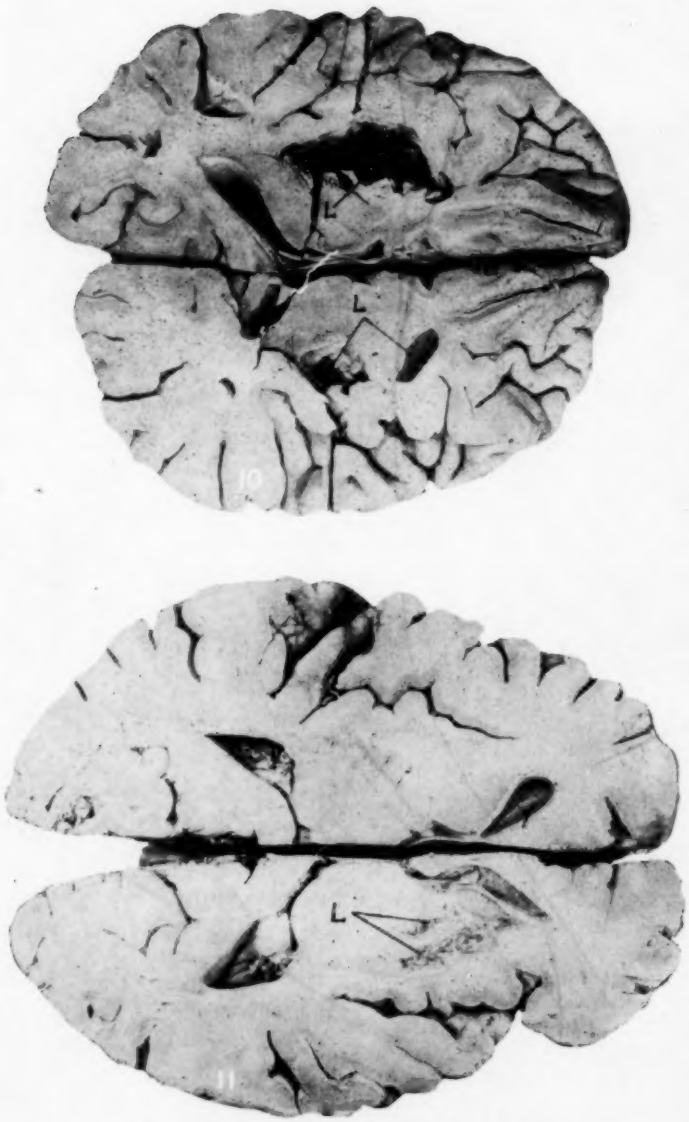

Plate 2.—Fig. 10 shows the coronal section through the corpus striatum of human brain 1843 (case 1). Fig. 11 shows the coronal section through the corpus striatum of human brain 1333 (case 2). *L* indicates the lesion.

fibers continued mediad above the column of the fornix to terminate in the nucleus mammillo-infundibularis (Malone). The majority of these fibers ran caudad in Forel's field H_2 and terminated largely in the ventromedial region of the substantia reticularis hypothalami and the region ventromedial to the mammillothalamic bundle of Vicq d' Azyr (nucleus mammillo-infundibularis of Malone, nucleus infundibularis anterior of Winkler and Potter [plate 4, fig. 1]).

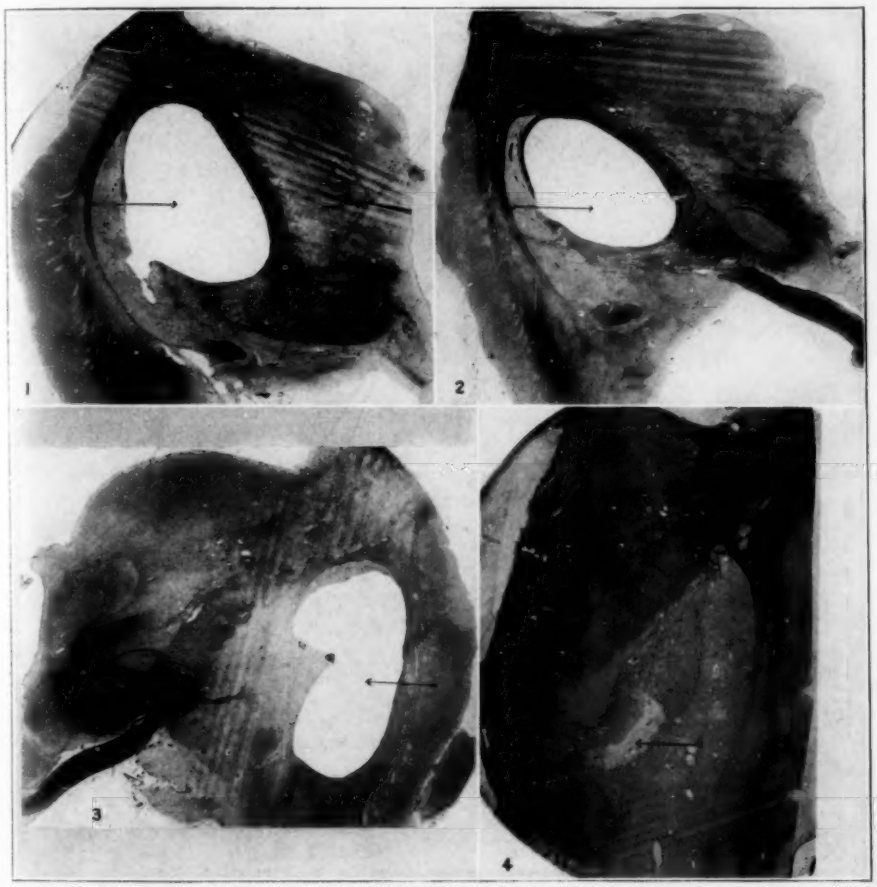

Plate 3.—Sections through human brains stained with iron hematoxylin. The arrow indicates the lesion in the corpus striatum. Figs. 1 and 2 show brain 1843, left side. Fig. 3 shows brain 1843, right side and fig. 4, brain 1333, right side.

A few passed through the supramammillary commissure to the same region of the opposite side. None of this group of fibers reached the red nucleus.

2. A large number (estimated to be more than 6,000) of fine degenerated fibers, appearing to arise from both divisions of the globus pallidus, passed obliquely through the basal third of the cerebral peduncle as many small fasciculi. These entered directly into and terminated in the subthalamic nucleus of Luys (plate 4, fig. 2).

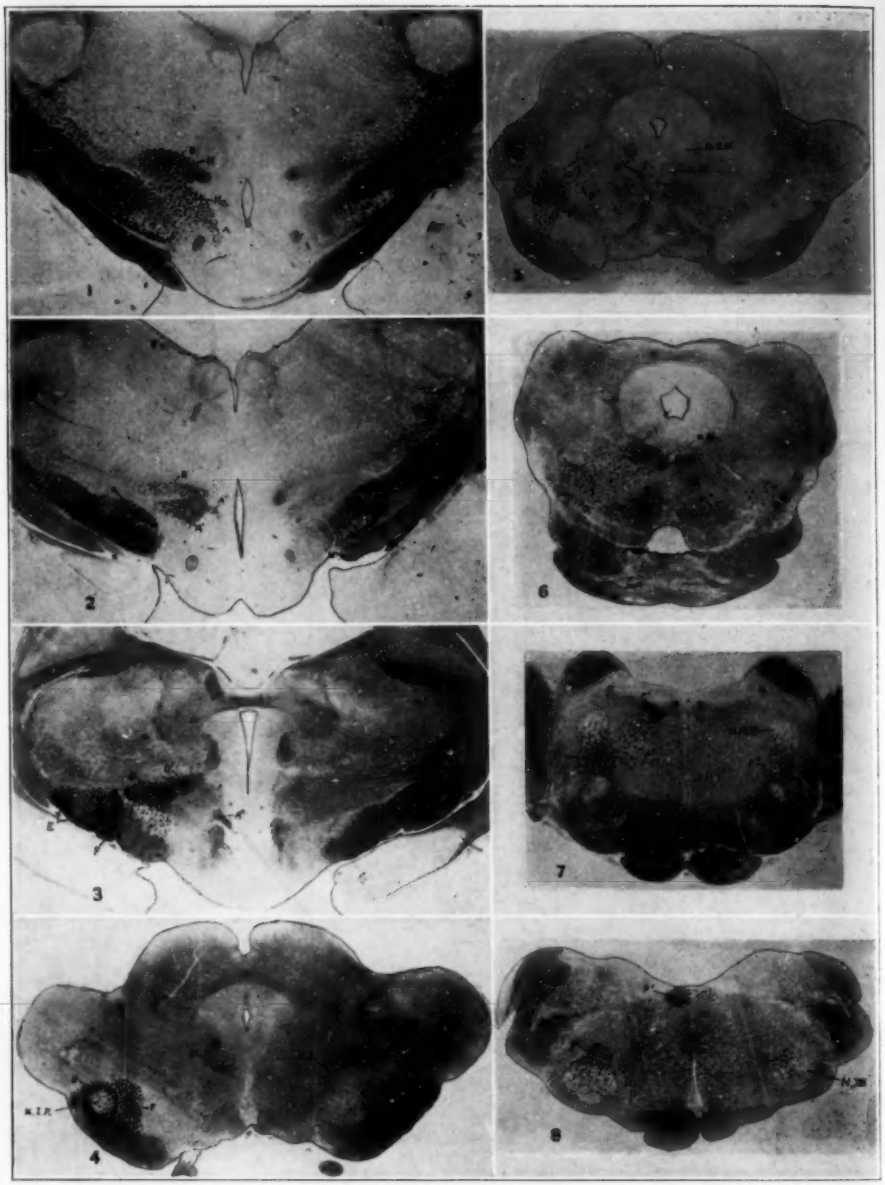

Plate 4.—A series of cross-sections of the brain stem of the cat, on which have been stippled the degenerations following a lesion in the corpus striatum. Tract *F* is taken from cat 448; the others from cat 444.

H indicates Forel's field; H_2, Forel's field H_2; *N. E. W.*, nucleus of Edinger-Westphal; *N. I.*, interstitial nucleus; *N. I. P.*, intrapeduncular nucleus; *N. III*, oculomotor nucleus; *N. IV*, trochlear nucleus; *N. N. V.*, masticator nucleus; *N. VII*, facial nucleus; *A*, fibers passing through Forel's field H_2 to the nucleus mammillo-infundibular nucleus; *A'*, fibers of Forel's field H_2 to the ventromedial part of Forel's field; *A''*, fibers of Forel's field H_2 crossing in the supramammillary commissure; *B*, striofugal fibers to the cephalic part of the substantia reticularis hypothalami (nucleus of Forel's field); *C*, striosubthalamic fasciculus; *D*, fasciculus to caudal part of the substantia reticularis hypothalami (nucleus of Forel's field); *D'*, fibers to the interstitial nucleus, nucleus of Darkschewitsch, oculomotor nucleus and the nucleus of Edinger-Westphal; *E* and *E'*, fibers to the intrapeduncular (motor division of substantia nigra) and peripeduncular nuclei (Jakobsohn), respectively; *F*, *F'*, *F''*, primary, secondary and crossed divisions of the striobulbar fasciculus to the masticator, facial ambiguus and the trochlear, abducens and hypoglossal nuclei.

3. A large number (probably more than 5,000) of fine degenerated fibers from the globus pallidus inclined more gradually through the medial half of the basis pedunculi. They continued dorsocaudad through and below the caudal end of the subthalamic nucleus of Luys and entered the caudal part of the subthalamus ventrocaudal to the thalamus (caudal portion of the substantia reticularis hypothalami). Many of these fibers passed dorsomediad in front of the red nucleus and terminated, some in the interstitial nucleus of Cajal, some in the nucleus of Darkschewitsch, some crossed in the posterior commissure to these two nuclei of the opposite side, while the remainder turned caudad to reach the oculomotor nucleus. A few degenerated fibers terminated among the most cephalic scattered cells of the red nucleus. The great majority of this group, however, terminated in the caudal part of the subthalamus as already described. This ending will be discussed later.

4. Approximately 8,000 fine degenerated fibers, apparently from the medial division and the ventral part of the lateral division of the globus pallidus, moved outward along the ventral surface of the basis pedunculi until they reached its most lateral part. Here they passed through the basis pedunculi in two large, fairly distinct groups with scattered fibers between. The largest group passed through the region of junction of the lateral third with the middle third of the peduncle and reached its dorsal surface cephalad to the substantia nigra, in contact medially with a group of coarse undegenerated fiber bundles, the pes lemnisci (lateral pontile bundle of Schlesinger [plate 4, fig. 2]). A second group of these fibers passed through the extreme lateral tip of the peduncle. These two groups then came together and continued caudad to end in the following manner: (*a*) The majority ran caudad through, and ended in, an elongated nucleus composed of large cells (intrapeduncular nucleus of Malone). This nucleus was about 3 mm. long. It was located in the lateral part of the so-called substantia nigra, dorsal to the lateral portion of the basis pedunculi, and shifted dorsolaterally as it was followed caudad (plate 4, fig. 4), disappearing just cephalad to the pons. (*b*) A considerable number continued caudad and ended in a large, somewhat triangular area immediately ventrolateral to the medial lemniscus at the caudal level of the midbrain. (*c*) A few more medially placed fibers passed dorsally into the medial lemniscus but could not be traced to their termination. They probably belonged to the group that will be described later as the lateral striobulbar fasciculus, which is not sufficiently degenerated in this specimen to be separated from the fibers described above.

5. There is some degeneration in Meynert's superior commissure, but a break in the series at this level makes it impossible to trace the fibers to their destination.

6. Owing to the injury of the external capsule, many of its fibers degenerate dorsally. A great number of degenerated fibers also pass through the temporal division of the anterior commissure to the external capsule of the opposite side.

7. Owing to injury of the optic tract, it carries a great many degenerated fibers to the superior colliculus and lateral geniculate body of the left side.

8. There was a slight injury to the internal capsule, resulting in a few scattered degenerated fibers passing down through the basis pedunculi.

9. A number of degenerations appeared which could not be attributed to the lesion in the corpus striatum. Considerable degeneration came in with the trigeminal nerve, partly, at least, because of injury of superficial nerves incident to the operation. The cochlear, and to a small degree the remaining cranial nerves, carried some degenerated fibers. There was also some degeneration in the rubrospinal and tectospinal tracts and the medial lemniscus.

Cat 471.—The cat was half grown and was highly domesticated. The lesion was placed in the lenticular nucleus of the left side. The animal was killed after ten days.

Symptoms.—The animal recovered from the immediate effects of the operation within a few hours. It became extremely restless, nervous and irritable and was almost continually on the move within the cage night and day. It meowed almost constantly. When standing, the right front foot was rhythmically raised and the ankle and toes flexed in a grasping manner (athetosis). This was also accompanied by tremor. During this time, the left front foot was shifted about restlessly and on rare occasions was flexed spasmodically.

The animal exhibited right circus movements at times, and at other times left circus movements. The rotation to the right was more frequent and more persistent, however.

On the fourth day, the cat was observed to turn to the left with the body flexed to the left and the head bent around to the left side. The hind feet remained almost in the same spot, and the animal turned around them in a small circle. In this manner, it would make several rapid successive rotations. The process seemed entirely spasmodic, and the animal seemed unable to control or stop it at will. It might be starting toward food or eating, when suddenly it would stop and make a few rapid rotation movements and then continue immediately to finish the action that it was engaged in performing when the rotation movement interfered. There were short intervals when, if not excited, the animal was able to walk in a straight direction but on being called, or having food presented, or any other factor which excited it to purposeful activity, the circus movements became more rapid and more persistent. When it was picked up during these circus movements, it was found that the muscles on the left side were hypertonic and that the body could not be straightened out without applying a great deal of force.

Two days later, the cat was found to exhibit right circus movements. These were similar to those to the left, but were more rapid and continued for a greater length of time. These movements might begin at any time without any apparent reason and might last from a few seconds to several minutes. During right rotation, the animal behaved as if it was in a hypnotic trance and was trying to reach a spot on the right hip. The eyes remained fixed on that point and any attempt to attract the attention of the animal passed unnoticed, whereas in left rotation the animal's mind seemed free and it was always conscious of its surroundings.

The following day the animal again exhibited left rotation, but to a less marked degree than before.

The left pupil was smaller than the right. The leg retraction reflexes, tested on the fourth day, were equally good on both sides but were weaker in the front than in the hind legs. However, these reflexes became much exaggerated two days later. At times, when the animal was comparatively inactive, successive waves of fine tremor passed rhythmically over the body. It swallowed with great difficulty and seemed unable to take solid bits of food into the mouth. This difficulty of taking food was apparently due, at first, to a spasticity or hypertonic condition of the muscles. After eight days, the muscles relaxed and became somewhat hypotonic and the mouth could be opened easily. The jaws were snapped open and shut in a characteristic mechanical manner, each movement seeming to require voluntary effort. The animal still swallowed with difficulty, and the tongue was handled awkwardly, as though partially paralyzed. When the animal attempted to eat, the head jerked spasmodically at brief intervals, and a fairly coarse tremor passed over the neck and body.

Lesion.—The lesion was large, and involved the putamen and globus pallidus of the left side. It began at a level slightly cephalad to the crossing of the anterior commissure. At that level, a long narrow lesion extended through the pyriform and central olfactory lobes ventral to the putamen. This enlarged caudally. At the level of the anterior commissure, it extended dorsad into the claustrum and ventral portion of the anterior gyrus sylvii of the cortex. It passed lateral to the putamen, injured the ventral portion of the globus pallidus and a spur of it destroyed a small part of the ventromedial portion of the internal capsule. It extended ventrad into the pyriform and posterior olfactory lobes. More caudad, the lesion retained the same relative size and position, destroying the ventral portion of the putamen and all of the globus pallidus at their caudal level. The spur which passed into the internal capsule ended in the cephalic and ventral part of the medial division of the globus pallidus, causing some injury to that division (figs. 2 and 3, plate 1). A part of the lesion extended into the cortical radiations caudal and dorsal to the putamen, causing considerable injury to these fibers. The most medial part encroached on the optic tracts.

Degenerations.—1. (*a*) More than 2,000 fine degenerated fibers arose from the injury in the ventrocephalic part of the medial division and from the lateral division of the globus pallidus. They passed as a diffusely scattered group dorsad and slightly caudad, through the internal capsule and zona incerta, and turned caudad in the nucleus substantia reticularis hypothalami of Malone (nucleus of Forel's field), and ended in the cephalic part of that nucleus. (*b*) Between 2,500 and 3,000 degenerated fibers, not so fine as those just described, arose mainly in the lateral division of the globus pallidus. They passed through the basal (medial) third of the internal capsule and turned medially into Forel's field H_2. Some of them continued medially above the column of the fornix and terminated in that region. Others ended on cells among the fibers of Forel's field H_2. The majority of these degenerated fibers continued caudad along the ventral border of the nucleus substantia reticularis hypothalami for some distance and then bent sharply dorsad to end in the ventral region of that nucleus and around the mammillothalamic fasciculus, except a small number, which crossed in the supramammillary commissure to end in the corresponding region of the opposite side.

2. Approximately 3,000 fine degenerated fibers which appeared to arise, mostly at least, from the medial division of the globus pallidus, passed caudad and somewhat dorsad through the basis pedunculi and ended in the subthalamic nucleus of Luys.

3. A large number (6,000?) of fine degenerated fibers from the lateral division of the globus pallidus passed obliquely through the medial two thirds of the basis pedunculi. These were diffusely scattered through the peduncle, except at a point ventrad to the lateral border of the subthalamic nucleus of Luys, where many of them passed through in a group. This more concentrated group passed just lateral to the subthalamic nucleus, while the remaining fibers passed caudal to that nucleus, and they all continued dorsad into the region ventral to the thalamus. Most of these fibers ended in the caudal part of the subthalamic region caudoventral to the thalamus and at the most cephalic level of the red nucleus. A considerable number, however, passed dorsomediad in front of the red nucleus into the tegmentum. Some of the striotegmental fibers terminated in the interstitial nucleus of Cajal and the nucleus of Darkschewitsch. Two small fasciculi continued caudad, one to end in the oculomotor nucleus and the other in the nucleus of Westphal-Edinger of the same side, and a few in

the nuclei of the opposite side. A few fibers terminated among the most cephalic ganglion cells of the red nucleus, and a few crossed in the decussation of Forel to the opposite side.

4. A group of fine degenerated fibers arose from the medial division and perhaps also the ventral part of the lateral division of the globus pallidus and passed outward along the ventral surface of the basis pedunculi, as described in the previous case. They then passed through the peduncle in two main groups: the first through the region of junction of the lateral third with the medial two thirds of the peduncle, and the second through the outermost part of the peduncle. These two groups of fibers reached the dorsal surface of the peduncle at the cephalic level of the substantia nigra. They came together in a large, somewhat scattered field, dorsal to the outer part of the basis pedunculi. Among the degenerated fibers as they passed caudad were a great number of small fasciculi of coarser undegenerated fibers and many large cells on which most of the degenerated striate fibers ended. These cells continued caudad to the cephalic level of the pons (intrapeduncular nucleus of Malone). A part of the remaining degenerated fibers ended in the triangular area ventrolateral to the medial lemniscus at the lower level of the midbrain.

5. Approximately from 2,500 to 3,000 degenerated fibers (resembling those of Forel's field H_2 arose apparently from the dorsal part of the globus pallidus and passed caudodorsad through the basis pedunculi medial to the group of fibers already described (4), at about the junction of the middle with the lateral third of the peduncle (plate 4, fig. 4). They reached the dorsal surface of the basis pedunculi at the caudal level of the midbrain and the cephalic level of the pons and passed directly dorsad into the medial lemniscus, accompanied by a few degenerated cortical fibers. They then shifted gradually through the medial lemniscus in the cephalic half of the pons and came to occupy a fairly large area in the ventrolateral part of the reticular formation (plate 4, fig. 5). The brachium conjunctivum cut through the dorsal part of the fasciculus. Through the caudal half of the pons, this fasciculus shifted slightly dorsad in the lateral reticular formation and occupied the same area as the rubrospinal tract (plate 4, fig. 7). In its course through the pons, a considerable number of fibers left this fasciculus and shifted dorsomedially through the reticular formation and took a position lateral to the median longitudinal bundle. Some fibers passed to the opposite side through the decussation of the brachium conjunctivum. The main fasciculus, however, retained its position in the lateral reticular formation and continued directly caudad. The most dorsally placed fibers terminated in the masticator nucleus. The most ventrally placed fibers continued caudad and ended, for the most part at least, in the facial, and ambiguus nuclei. Of the fibers which left the fasciculus and moved dorsomedially through the reticular formation, a few ended in the abducens and trochlear nuclei. The remainder turned caudad in the dorsal reticular formation lateral to the median longitudinal bundle (plate 4, fig. 7). In the medulla they joined the median longitudinal bundle and part of them decussated to the opposite side. Many of them ended in the hypoglossal nucleus of the same and of the opposite side, but the termination of the remainder is not known.

6. As a result of the injury to the external capsule and to the olfactory area of the cortex, both the temporal and the olfactory division of the anterior commissure carried a great many degenerated fibers.

7. A great many degenerated fibers from the injured part of the cortex and the cortical radiations caudal to the lenticular nucleus passed through the corpus callosum to the opposite side. Many degenerated into the gyri sylvii

anterior and posterior and gyrus ectosylvius medius. A considerable number of degenerated fibers were scattered throughout the basis pedunculi.

8. Injury to the optic tract caused a great deal of degeneration to the lateral geniculate body, superior colliculus and thalamus of the same side, as well as some degeneration to the opposite side.

9. Apparently all of the fibers in the superior commissure of Meynert (anterior hypothalamic commissure) which arose on the side of the lesion were degenerated. These arose from the medial division of the globus pallidus and the ventral part of the lateral division, crossed the midline dorsocaudad to the optic tracts and commissure of Gudden and divided into two parts. The main division of Meynert's commissure runs laterad to terminate in both the lateral and medial divisions of the globus pallidus of the opposite side. The other division, which consists of only a small part of the commissure, ran dorsolaterad and caudad to the medial side of Forel's field H_2 and terminated in that region.

10. There was considerable degeneration in the fornix of both sides, arising apparently from the lesion in the olfactory brain.

11. There were a number of degenerations in this brain which could not be attributed directly to the lesion. They included some degeneration in the medial lemniscus; posterior commissure; trapezoid body; scattered degeneration through the reticular formation, and degeneration along the cranial nerve roots, especially the trigeminal and cochlear nerves.

Cat 448.—In a full grown cat, a lesion was made in the corpus striatum of the left side. The animal was killed after eleven days.

Symptoms.—When the lesion was placed, the pupil of the left eye dilated and remained so for a few hours. Following that there was, at times, a rapid change in the relative size of the two pupils; that is, the left pupil might be momentarily smaller than the right, then it would suddenly dilate and then again constrict in a somewhat rhythmic manner. At other times, the pupils appeared equal and normal.

The animal was somewhat sluggish for three or four days and then became active.

There was a tendency to left rotation with a rigidity of the muscles on the left side of the body. It did not, however, show the extreme hypertonicity exhibited by those previously described. The leg retraction reflexes were equal and apparently normal. There was slight paralysis of the left front leg.

The most pronounced symptoms in this animal were exhibited in connection with taking, manipulating and swallowing food. This seemed due at first to a spasticity of the muscles of the jaws and tongue. There was difficulty in getting the jaws open. The tongue was lapped out and handled in a stiff manner when the cat attempted to eat. There was difficulty in retaining food in the mouth, and the animal chewed stiffly and awkwardly. Swallowing was accomplished with great effort, even though the quantity of food was small.

After about eight days, the muscles of the jaw and tongue began to relax and to lose their tonus almost entirely. The lower jaw sagged so that the mouth remained partially open. The tongue protruded out of the mouth and hung in a listless manner. The movements of both tongue and jaws were limited, weak and awkward, requiring distinct voluntary effort. This animal was never observed to meow.

On the seventh day after the operation, the temperature of this animal was 100.2 F., the rate of the heart beat, 60 and respirations 36 a minute.

Lesion.—The lesion was fairly large, and was in the region of the lenticular nucleus of the left side. At a level cephalad to the crossing of the anterior commissure, it penetrated the gyrus sylvius anterior and extended ventromedially into the lateral and central olfactory gyri until it came almost to the surface. A narrow dorsal extension of it destroyed the claustrum. Medially, it skirted the lateral surface of the putamen. A spur of it pierced the external capsule, destroyed the middle portion of the putamen and slightly injured the internal capsule, while another spur destroyed the external capsule ventrad to the putamen. More caudally, the lesion became smaller and moved dorsomedially. At the level of the anterior commissure, only a somewhat narrowed band extended ventromedially into the posterior olfactory lobe (plate 1, fig. 4 and 5). Dorsally, it encroached slightly on the corona radiata and injured the most ventral fibers of the outer half of the internal capsule. Medially, it destroyed all the putamen and the most lateral part of the globus pallidus. Continuing caudad, the lesion diminished rapidly in size until at the level of the optic commissure it destroyed all the lateral division of the globus pallidus, except perhaps a few cells lying close to the internal capsule, and extended into the ventromedial part of the putamen (plate 1, fig. 5). In the most caudal part of the lenticular nucleus it extended between the putamen and the globus pallidus, destroying the lateral and dorsal fourth of the latter and the middle fourth of the former. Only the cephalic end and the medial part of the caudal tip of the lateral division of the globus pallidus escaped injury. The medial division of the globus pallidus and the lateral part of the caudal three fourths of the putamen were also uninjured.

Degenerations.—1. *(a)*. Approximately 1,000 fine degenerated fibers from the globus pallidus passed through the basal third of the cerebral peduncle cephalad to the subthalamic nucleus of Luys, thence directly dorsad into the substantia reticularis hypothalami (Forel's field). The fibers then turned caudad and terminated within that nucleus. *(b)* More than 600 fibers of somewhat larger caliber arose in the globus pallidus, passed through the basal third of the cerebral peduncle and turned medially into Forel's field H_2. A few of these terminated in the region medial to the column of the fornix and on scattered cells within Forel's field H_2. The majority of them continued caudad in Forel's field H_2 and terminated in the ventromedial region of the substantia reticularis hypothalami (Forel's field), while the remainder crossed in the supramammillary commissure to the same region of the opposite side.

2. Approximately 3,500 fine degenerated fibers passed through the medial third of the cerebral peduncle and terminated in the subthalamic nucleus of Luys.

3. A large number of fine degenerated fibers passed through the cerebral peduncle in its basal half, thence dorsad in close contact with the caudal end of the subthalamic nucleus and entered the region ventrad to the thalamus. A small number of these continued dorsomedially in front of the red nucleus and terminated in the interstitial nucleus of Cajal, the nucleus of Darkschewitsch, the oculomotor nucleus and the nucleus of Westphal-Edinger. A few turned caudad among the cephalic scattered cells of the red nucleus. A great majority of this group of fibers, however, terminated in the caudal part of the subthalamic region.

4. Approximately from 3,000 to 3,500 fine degenerated fibers moved outward along the ventral surface of the cerebral peduncle and passed obliquely through its lateral third. These fibers emerged from the peduncle at the cephalic level of the substantia nigra and became grouped about a somewhat rounded mass of cells (intrapeduncular nucleus of Malone). The degenerated striate fibers

continued caudad and somewhat dorsolaterad and gradually terminated largely on this group of cells. Some fibers continued into the region ventrolateral to the medial lemniscus at the caudal level of the midbrain.

5. From 4,500 to 5,000 degenerated fibers, somewhat coarser in nature, passed through the cerebral peduncle between its lateral and its middle thirds and then continued dorsocaudad and somewhat laterad through the substantia nigra, medial to the group of fibers already described (4). These fibers entered the medial lemniscus in its ventrolateral part at the cephalic level of the pons. Shifting gradually through the medial lemniscus, they came to occupy a considerable area in the ventrolateral part of the reticular formation bounded externally by the lateral lemniscus and ventrally by the medial lemniscus. The most ventrally placed fibers of the brachium conjunctivum cut through this bundle as they crossed the reticular formation. At the caudal level of the pons, the rubrospinal tract came to occupy the same area as the degenerated striate fibers: an area in the lateral part of the ventral half of the reticular formation, dorsal to but somewhat withdrawn from the medial lemniscus, while the lateral lemniscus was closely applied to their lateral side. The bundle at this level carried more than 2,000 fibers. In its course through the region of the pons, the tract gave off many fine scattered fibers which took an irregular course dorsomedially through the reticular formation and formed a second tract, laterad to the median longitudinal bundle, which will be described later. Also a considerable number of fibers left this bundle and decussated in the caudal part of the decussation of the brachium conjunctivum to take the same position and end in the same manner as the uncrossed tract. As the large homolateral division of this tract continued caudad, its dorsally placed fibers ran directly into the cephalic end of the masticator nucleus and terminated on the cells of that nucleus. The more ventrally placed fibers ran caudad dorsal to the superior olive until the facial nucleus appeared in their midst. A number of them ended in the facial nucleus. A small group of remaining degenerated fibers continued caudad dorsal to the facial nucleus and ended, for the most part at least, in the nucleus ambiguus.

A great many fine degenerated fibers left the bundle just described in its course through the pons. These fibers ran in a general dorsomedial and caudal direction. They were scattered throughout the dorsal part of the reticular formation, and took an irregular course among the heavy fasciculi of longitudinally directed fibers. Some of them passed to the trochlear and abducens nuclei. The greater number, however, turned caudad and formed a somewhat scattered fasciculus in the dorsal part of the reticular formation lateral to the median longitudinal fasciculus. There were approximately 500 of these degenerated fibers, which belonged to the striate system. More caudally they shifted mediad and became scattered among the fibers of the median longitudinal bundle. Some of the fibers decussated across the raphe and took a similar position on the opposite side. Many of them ended in the hypoglossal nucleus of the same and the opposite sides. The remainder continued caudad in the median longitudinal fasciculi. Their termination has not been determined.

The rapid diminution in number of the fibers of this fasciculus in its course through the upper part of the pons strongly suggests the possibility that some of the striate fibers terminate on nuclei of the reticular formation in this region.

6. The injury to the cortical radiations cephalad destroyed practically no descending fibers. Approximately 100 fibers degenerated downward in the pyramidal tract of the same side as a result of injury to the internal capsule.

7. Other degenerations not attributed to the lesion were: a few fibers in the tectospinal tracts; less than 200 fibers in the rubrospinal tract of each side; considerable degeneration in the trigeminal, cochlear, vestibular and to a less degree the remaining cranial nerve roots; frequent degeneration of the most superficial fibers near the surface of the brain stem.

Cat 445.—In a full grown cat, the lesion was placed in the corpus striatum of the left side. The animal died after nine days.

Symptoms.—The animal remained sluggish during the entire time following the operation. The right limbs were partially paralyzed, particularly the right front leg. The right front foot was frequently left in an awkward, unnatural position, sometimes laterally, sometimes caudally and sometimes under the body. Frequently the right ankle was flexed, and the animal stood on the anterior surface of it. These symptoms were apparently due partially to paralysis and partially to a loss of deep sensibility. The leg retraction reflexes were poor on the right side. During walking, both right legs were spastic and they remained in an extended position when the animal was picked up. There was a tendency to left circus movements.

The animal was able to take food into the mouth with only a fair degree of success and had great difficulty in manipulating it in the mouth as if movements of both the tongue and jaw were hampered. This seemed due to a spasticity of the muscles. The cat slobbered continuously. After seven days, there was a relaxation of the muscles of the tongue and jaw. The lower jaw sagged so that the mouth was partly open. The tongue hung listlessly out of the mouth. The animal still slobbered incessantly when it attempted to overcome this, the tongue was lapped in a paralyzed, almost entirely helpless manner and the animal was apparently unable to draw the tongue back into the mouth or to close the jaws. Swallowing was effected with great difficulty.

The animal possessed a weak, croaky, deep toned meow similar to the weak bleating of a lamb. The left pupil was slightly smaller than the right. Simultaneously with the relaxation of the muscles of the tongue and jaw a general relaxation of all the muscles of the body occurred, so that the animal became entirely helpless.

On the seventh day, the temperature was 101.7 F., the rate of heart beat, 72 a minute, and respirations, 21 a minute.

Lesion.—The lesion was a fairly large one in the corpus striatum of the left side (plate 1, figs. 6 and 7). At the level of the anterior commissure, it destroyed the dorsal part of the claustrum and the dorsal three fourths of the putamen and globus pallidus. Dorsomedially, it penetrated the internal capsule, destroying its lateral half and extending for 3 mm. into the caudate nucleus. At the anterior level of the thalamus, the lesion became more restricted, destroying the dorsal two thirds of the putamen and of the lateral division of the globus pallidus and causing slight injury to the most ventral fibers in the lateral part of the internal capsule and cortical radiations. More caudad it grew still smaller, until at about the junction of the caudal one fourth with the cephalic three fourths of the lenticular nucleus, it involved only the dorsal one third of the putamen and globus pallidus and injured a few of the most ventral fibers in the middle portion of the internal capsule. It then divided, one small spur ending in the internal capsule dorsal to the most caudal part of the globus pallidus, while another small, slitlike lesion extended caudad in the external capsule and lateral side of the putamen.

Degeneration.—This specimen did not stain satisfactorily in places so that it could not be used for a careful detailed study of the degenerations. The following general conclusions, however, may be arrived at from a study of this series:

1. The fine degenerated fibers passing to the substantia reticularis hypothalami and subthalamic nucleus of Luys were relatively few in number. There were only a few of the coarser fibers degenerated through Forel's field H_2 into the mammillo-infundibular nucleus and substantia reticularis hypothalami.

2. The number of fine degenerated fibers passing to the caudal part of the subthalamus, the interstitial nucleus, the nucleus of Darkschewitsch, the oculomotor nucleus and the red nucleus, was somewhat smaller than in the previous cases, in which the lesion was more extensive.

3. The group of fibers which passed outward along the ventral surface of the basis pedunculi and ended on nuclei in the lateral portion of the zona incerta was practically undegenerated.

4. The tract arising in the dorsal part of the globus pallidus passing through the medial lemniscus (lateral pes lemnisci) and down to the masticator, facial, and ambiguus nuclei, giving off a branch to the abducens, trochlear and hypoglossal nuclei, was grossly degenerated in this specimen. The degenerated striate fibers were fewer than in cat 448, but many degenerated pyramidal fibers entered into the bundle in this case.

5. A few degenerated fibers from the lesion in the dorsal portion of the globus pallidus crossed in Meynert's commissure to end in the globus pallidus of the opposite side.

6. The pyramidal tract was practically one-half degenerated as a result of the injury to the internal capsule.

Cat 434.—In a mature, young cat, a lesion was placed in the corpus striatum of the left side. The animal died of enteritis on the ninth day.

Symptoms.—The animal showed a normal temperature of 100.9 F. preceding the operation. Forty-five minutes after the operation, the temperature was 99.9 F. The cat had difficulty in muscular control; right rotation and severe, fairly coarse tremor immediately followed the operation. The tremor disappeared within a few hours. Two days after the operation, the animal was active and restless, meowed a great deal and had good use of the legs.

The cat showed a tendency to right circus movements, sometimes turning around in a small circle several times in succession. The circus movements disappeared after seven days, but the restless, nervous condition persisted until the animal contracted enteritis and died on the ninth day. The animal shifted about restlessly while eating and had great difficulty in chewing and swallowing. It was able to take only small bits of solid food and that with a great effort. It then made elaborate, disorganized chewing movements similar to the movements made when an animal gets a string or a feather lodged in its mouth and attempts to displace it. It swallowed with great difficulty.

On the eighth day, the temperature was 103.4 F.; the rate of heart beat, 120 a minute and the rate of respiration, 42 a minute.

Lesion.—The lesion was fairly large, in the corpus striatum of the left side (plate 1, fig. 8). At the level of the anterior commissure it was elongated, extending along the ventral surface of the internal capsule. It destroyed all the putamen and the part of the globus pallidus dorsal to the temporal division of the anterior commissure. Dorsally, it destroyed the claustrum and extended slightly into the cortical radiations and the adjoining part of the internal capsule. A slit-like

prong penetrated through the internal capsule in its most lateral part, while another small projection entered the ventral part of the internal capsule just dorsal to where the anterior commissure penetrates it. Laterally, the lesion destroyed the dorsal half of the gyrus sylvius anterior, and ventrally a narrow portion extended for some distance into the posterior olfactory lobe. More caudally the injury to the internal capsule enlarged to take in nearly its entire lateral half and involved a considerable area in the dorsal part of the head of the caudate. At the level of the optic chiasma it extended dorsad, lateral to the thalamus, injured the internal capsule and corona radiata, and ended caudad in the dorsal formatio reticulata of the thalamus. Caudally, the ventral part of the lesion became smaller, destroying all of the lateral division of the globus pallidus and all but the most ventral part of the putamen. At this more caudal level, the lesion withdrew from the corona radiata and gradually grew smaller, confining itself to the dorsal part of the lenticular nucleus and leaving a constantly widening area uninjured in the ventral part of the putamen and globus pallidus. Thus the most ventral part of the putamen was injured throughout almost its entire length, as well as the dorsal half of the putamen and globus pallidus in their caudal fourth. The medial division of the globus pallidus was entirely free from injury.

Degenerations—1, (*a*). A few extremely fine degenerated fibers from the lateral division of the globus pallidus passed through the medial side of the basis pedunculi in an obliquely dorsocaudal direction, thence directly through the zona incerta and entered the cephalic part of the substantia reticularis hypothalami. A great many coarse degenerated cortical fibers from the injury lateral to the thalamus passed through the lateral nucleus of the thalamus and ended in the same region as these fine fibers from the globus pallidus. (*b*) Approximately 500 or 600 coarser fibers left the lateral division of the globus pallidus in its most caudal part, passed ventrally to and through the medial division of the nucleus, thence obliquely dorsocaudad through the most medial part of the basis pedunculi, then turned medially into Forel's field H_2. Some fibers ended in this region. The remainder ran caudad for a short distance and turned dorsad to end in the region ventromedial to the substantia reticularis hypothalami, with the exception of a few, which crossed through the supramammillary commissure to the same region of the opposite side.

2. A great many fine degenerated fibers (4,000 or more), left the lateral division of the globus pallidus in its caudal part, passed obliquely dorsocaudad through the medial half of the basis pedunculi and ended directly in the subthalamic nucleus of Luys.

3. A large number of fine fibers passed through the basis pedunculi caudal to and in close contact with the subthalamic nucleus, thence dorsad to terminate for the most part in the caudal part of the subthalamic region. Many of these fibers passed cephalad to the red nucleus and ended largely in the interstitial nucleus of Cajal and the nucleus of Darkschewitsch. Some continued down to the oculomotor nucleus, while a few passed among the scattered cells of the red nucleus to end apparently on those cells.

4. In this specimen, the cortical projection fibers did not run through the midbrain as a single compact bundle in the basis pedunculi, as is usually the case. A number of large fasciculi of cortical fibers (occipitotemporopontile fibers) collected in the lateral region of the zona incerta, quite separated from the lateral side of the basis pedunculi and dorsal to it. These fasciculi shifted gradually dorsolaterad and continued caudad to enter the pons. A large number (estimated to be from 1,000 to 1,500) of fine degenerated fibers from the globus pallidus passed

through the basis pedunculi in its lateral third and turned caudad among the aberrant corticopontile fasciculi. These ended partly on large cells distributed among the fasciculi of cortical fibers (intrapeduncular nucleus of Malone) and partly on the smaller cells in the area surrounding these fasciculi at a lower level (peripeduncular nucleus of Jacobsohn). Some continued caudad to the cephalic level of the pons before ending on these nuclei. Undegenerated fibers, which seemed to arise from the groups of cells on which the striate fibers terminated, continued caudad with the corticopontile fasciculi to the cephalic level of the pons, but their destination could not be determined.

5. From 4,000 to 5,000 fine degenerated fibers arising from the dorsal part of the globus pallidus passed dorsocaudad through the basis pedunculi at about the junction of its lateral third with the medial two-thirds. These continued dorsocaudad through the lateral part of the substantia nigra, passed into the medial lemniscus at the caudal level of the midbrain and took a caudal course. A few, from eight to twelve coarse degenerated cortical fibers, were included among this group. The large group of degenerated striate fibers emerged from the medial lemniscus in the proximal part of the pons and came to occupy a large area in the ventrolateral part of the reticular formation. The most ventral fibers of the brachium conjunctivum crossed through the striate fasciculus. It was then displaced dorsally by the superior olive. The masticator nucleus appeared among the most dorsal degenerated fibers of the fasciculus, and some of them terminated within it. The fibers diminished greatly in number (about one-half) before reaching the level of the masticator nucleus. Some of the fibers which entered the medial lemniscus at the highest level ran dorsad through the reticular formation to reach the trochlear and abducens nuclei. Others left the main group in its course through the pons and ran obliquely dorsomediad and caudad through the reticular formation to take a position lateral to the median longitudinal bundle. A few reached the opposite side in connection with the decussation of the brachium conjunctivum. Sections were not available below the level of the masticator nucleus in this series. The rapid diminution in the degenerated fibers before the level of the masticator nucleus was reached suggested the possibility that some of them may end in reticular nuclei of the pons.

6. Meynert's superior (hypothalamic) commissure was partially degenerated in this specimen. The fibers left the lateral division of the globus pallidus, crossed the midline dorsally to Gudden's commissure, and most of them entered the globus pallidus of the opposite side. A few arched dorsally and then laterally and bent caudad in the ventromedial part of Forel's field H_2. These fibers seemed to terminate in this region.

7. Because of the lesion in the lateral part of the internal capsule, corona radiata and to a slight extent in the reticularis thalami, the following degenerations resulted: (*a*) There was much degeneration through the corona radiata from the level of the anterior commissure to the level of the medial geniculate body. This degeneration was distributed largely to the gyrus sylvius anterior and posterior, the gyrus ectosylvius medius and gyrus suprasylvius medius. (*b*) A great many fibers degenerated into the thalamus and hypothalamic region. (*c*) There was a considerable amount of degeneration in the pyramidal tract (approximately 5 per cent).

8. Degenerations not attributed to the lesion were: A fairly large amount of degeneration in the brachium conjunctivum of each side; some in the rubrospinal tracts; some in the optic tracts; a slight amount in the medial lemniscus

of both sides; some in the posterior commissure; some degeneration wherever fibers lay superficial on the surface of the brain stem; and some in the tectospinal tracts.

Cat 420.—In an adult cat, the lesion was placed in the lenticular nucleus of the left side. The animal died on the tenth day.

Symptoms.—The cat had difficulty in taking food into the mouth, which could not be opened easily or widely, apparently because of a spastic condition of the muscles. It licked small bits of food into the mouth, chewed stiffly and swallowed with difficulty. Meowing movements produced no sound. It was rather sluggish. The leg retraction reflexes were strongest on the left side.

Lesion.—The lenticular nucleus of the left side was involved in its caudal part (plate 1, fig. 9). At the level of the optic chiasma, it was confined laterally to the claustrum and extended ventrad into the posterior olfactory lobe. Medially, however, it destroyed all but the dorsal tip of the putamen and extended along the ventrolateral part of the globus pallidus, causing some injury to that nucleus. At about the beginning of the caudal third of the lateral division of the globus pallidus, a prong of the lesion ran medially, destroying its ventral part, while another projection injured the dorsal part of the putamen and globus pallidus. The globus pallidus remained uninjured in its caudal fifth, while the lesion became a narrow band in the form of an inverted V (A); one side of the V ran along the lateral part of the putamen, while the other extended caudad along the medial side.

Degenerations.—In this specimen, sections were not available below the caudal level of the midbrain.

1. *(a)* A small group of fine degenerated fibers (from 200 to 300), arising from the lateral division of the globus pallidus, passed through the internal capsule and the zona incerta directly through the lateral side of Forel's field H_2 and entered the cephalic part of the substantia reticularis hypothalami. *(b)* Many coarser degenerated fibers (approximately 1,500) from the globus pallidus passed through the medial third of the internal capsule and turned mediad into Forel's field H_2. Some seemed to end on cells in this region. The remainder passed caudad and ended largely in the region ventromedial to the substantia reticularis hypothalami, while a few crossed in the supramammillary commissure to the same nucleus of the opposite side.

2. A great many fine degenerated fibers from the globus pallidus passed obliquely through the medial third of the basis pedunculi and entered the subthalamic nucleus of Luys. These fibers entered the nucleus chiefly in its cephalic part.

3. A great many fine degenerated fibers (approximately 3,000) passed through the medial half of the peduncle at the caudal level of the subthalamic nucleus of Luys and entered the region caudoventral to the thalamus. Most of these ended in the caudal part of the subthalamus. Many ran dorsomediad in front of the red nucleus to the interstitial nucleus of Cajal, the nucleus of Darkschewitsch, and a few reached the oculomotor nucleus. A number of these fibers ran along the most cephalic cells of the red nucleus and probably ended on those cells.

4. About 3,000 fine degenerated fibers from the globus pallidus passed through the lateral third of the basis pedunculi beneath the lateral side of the substantia nigra at its cephalic level. They took a position in the lateral region of the substantia nigra dorsad to the basis pedunculi. They moved caudad and shifted somewhat dorsolaterad as they ended on the nuclei in this region.

5. A large number of fine degenerated fibers (2,500 or 3,000), with the addition of a few (twenty or thirty) large degenerated pyramidal fibers, passed

through the basis pedunculi in close relationship to the most medial fibers of the group already described (4). Here they were associated with a fasciculus of undegenerated fibers (lateral corticobulbar tract) to form the lateral pes lemnisci (lateral pontile bundle). This fasciculus passed dorsad among the fibers of the medial lemniscus at the lower level of the midbrain. Sections were not available below this level. This bundle of fibers, however, was identical with the one described in cats 471, 448 and 434 as being distributed to the masticator, facial, ambiguus, trochlear, abducens, and hypoglossal nuclei.

6. A few fibers were degenerated through Meynert's superior commissure to the globus pallidus of the opposite side.

7. The injury to the corona radiata caused a fairly large number of fibers to degenerate into the gyrus ectosylvius medius and suprasylvius medius. Injury to the internal capsule caused a degeneration of fibers scattered throughout the basis pedunculi. They comprised perhaps 1 per cent of the total number of fibers in the peduncle. There were also a great number of fibers from the injured region of the internal capsule and corona radiata medially into the thalamus and substantia reticularis hypothalami.

HUMAN BRAINS

CASE 1.—*History.*—A man, aged 37, was admitted to King's Park State Hospital, June 14, 1902. He had been a heavy drinker. When admitted he was poorly nourished and was blind in the left eye; the gait was slow, and he limped, because of a deformity of the right foot. The patellar reflexes were absent. The patient was confused, demented, rambling and disconnected in speech; he conversed in a childish manner, showed great irritability and made minor assaults on others. He was admitted to Binghamton State Hospital in 1909. At that time, he showed no insight into his condition; he talked to himself and had auditory hallucinations; his conversation was rambling and disconnected. He worked mechanically. The dementia progressively increased.

His health began to fail in 1918. On December 5, he suffered from severe epistaxis following which he was confined to bed. This was followed by cardiac failure and death three days later.

Diagnosis.—The condition was diagnosed as psychosis: mental deficiency.

Autopsy Report.—A cataract was present in the right eye, an old iritis in the left, and complete arcus senilis in each eye.

The arteries of the brain were markedly atheromatous throughout. The sulci were widened in the frontal region; the convolutions on the convexity were in general a little flattened. On sectioning, it was found that the right lenticular nucleus and the surrounding white matter in the frontal and parietal lobes were involved by a large, irregular, smooth-walled cavitation. A similar but much smaller cavitation existed on the left side. The heart was large; both sides were widely dilated, and the myocardium was greatly atrophied in the walls of both ventricles. The pancreas was fatty. In the liver, the cells in the outer portion of the lobules contained fat. There was round-cell infiltration in some Glisson's capsules. The kidneys showed great increase in connective tissue in both cortex and medulla; large amounts of parenchyma were replaced by scars. Many glomeruli showed hyaline changes.

Lesion.—A large cavity was present in the lenticular nucleus of each side (plate 2, fig. 10). On the left side was a large, irregularly shaped, smooth walled cavity which extended cephalocaudad almost the entire length of the lenticular nucleus. Throughout its extent, the lesion encroached on the ventral surface of the dorsal two thirds of the internal capsule, destroying about one half of its

fibers. The dorsal half of the globus pallidus was destroyed throughout its length. The lesion extended laterally into the putamen, leaving only a crescentic band of nuclear material on the lateral side free from injury. Approximately, the ventral half of both putamen and globus pallidus remained uninjured.

On the right side an irregular, smooth walled cavity was present, which was much smaller than that in the lenticular nucleus of the left side. Aside from a small cavity in the dorsal and another in the lateral part of the globus pallidus in its cephalic part, the lesion was confined entirely to the putamen. At a cephalic level it was divided into two limbs, one of which extended through the dorsal third, the other through the ventral third of the putamen. In the caudal part of the nucleus, the two limbs joined to form a single large cavity, which destroyed all of the putamen except a narrow lamina of gray matter along its medial side. There were many small degenerated areas following the course of blood vessels in the lateral segment of the globus pallidus.

Fiber Systems.—Left Side: 1. The ansa lenticularis (ventral division of the ansa lenticularis of von Monakow) appeared to be made up almost entirely of fibers that arose from the ventral uninjured portion of the globus pallidus and hence did not show any degeneration. Most of these collected in the internal medullary lamina in its ventral part, while a few joined the external medullary lamina. They then converged toward the medial part of the globus pallidus and formed a fasciculus, which passed around the medial side of the cerebral peduncle and turned dorsolaterad to join Forel's field H_2.

2. The striosubthalamic fasciculus (middle division of the ansa lenticularis of von Monakow) was made up of fibers which seemed to have their cells of origin in all parts of the globus pallidus, but more seemed to come from the ventral than from the dorsal part of the nucleus. A considerable number of degenerated fibers from the region of the lesion in the dorsal part of the globus pallidus passed through the internal capsule and ended in the lateral part of the subthalamic nucleus of Luys.

3. The fasciculus lenticularis of Forel, which appears to take origin largely in the middle region of the globus pallidus, carries many degenerated fibers. This fasciculus passes through the internal capsule lateral to the subthalamic nucleus of Luys and runs mediad over the dorsal border of that nucleus to reach Forel's field H_2. The degenerated fibers are too few in number, in comparison with the total number in Forel's field H_2, to be traced to their definite termination. However, it seems evident that the degenerated fibers disappeared from Forel's field cephalad to the red nucleus.

4. Throughout the cephalocaudal extent of the globus pallidus, fibers from the area of the lesion and from the region immediately ventral to the lesion ran dorsally and collected into many small, partially degenerated fasciculi on the ventral surface of the internal capsule at about the region of junction of its lateral with its middle third. They became directed dorsocaudad and shifted dorsally through the longitudinally directed fibers of the internal capsule. The first of these fibers reached the dorsal surface of the basis pedunculi at the caudal level of the globus pallidus. Others passed through the basis pedunculi more caudad through the region of the midbrain. Many small undegenerated fasciculi of cortical fibers from the lateral part of the basis pedunculi joined the group of striate fibers in its course through the midbrain. This large fasciculus of cortical and striate fibers formed what is known as the lateral corticobulbar tract (lateral pontile bundle of Schlesinger; lateral pes lemnisci). The group of fibers from the corpus striatum became separated into two divisions, each having a different termination. (*a*) Just caudal to the level of the subthalamic

nucleus, a considerable group of the finer fibers took a position on the lateral side of the lateral pes lemnisci. At first, these were not separated from the pes lemnisci. Scattered among them appeared cells that were not of the pigmented type characteristic of the substantia nigra. Soon this group of fibers and cells broke away from the remainder of the pes lemnisci and shifted gradually laterad, dorsal to the basis pedunculi. The degenerated fibers were gradually replaced by undegenerated fibers. In the caudal part of the midbrain, they occupied a small area dorsal to the most lateral tip of the basis pedunculi. The fasciculus here became more scattered through an area of small cells ventral and lateral to the medial lemniscus. The remaining degenerated fibers here suddenly disappeared, and the original degenerated fasciculus gave place to a similar group of fine undegenerated fibers. At the caudal level of the midbrain, this new fasciculus moved ventrad into the lateral part of the basis pedunculi and became lost among the cortical fibers.

(*b*) The second group of partially degenerated striate fibers, with many undegenerated cortical fibers, formed the lateral pes lemnisci proper. This fasciculus ran caudad and somewhat dorsolaterad through the substantia nigra. At the cephalic level of the pons, it turned obliquely dorsocaudad through the ventrolateral part of the medial lemniscus. Only the degenerated striate fibers could be traced beyond this point. In the upper part of the pons, they occupied a large area in the ventrolateral part of the reticular formation bounded laterad by the lateral lemniscus and ventrad by the medial lemniscus. The brachium conjunctivum cut through the dorsal part of the striate fasciculus as it crossed through the reticular formation. Many of the fine degenerated fibers shifted through the brachium conjunctivum and scattered through the dorsal reticular formation. The main group continued caudad in the ventrolateral part of the reticular formation. They became displaced dorsally by the superior olivary nucleus and formed a crescent on the ventromedial surface of the masticator nucleus. Many of the fibers ended in this nucleus. The remainder continued caudad into the region of the facial nucleus. The distribution of these fibers could not be traced further, but all indications tended to show that the distribution of this fasciculus was the same as was described in the cat.

Right Side: There was only the slightest trace of degeneration in the ansa lenticularis on the right side of this brain. There was only a slight amount of degeneration in the fibers from the globus pallidus which helped to form the lateral pes lemnisci.

Other Degenerations: In this specimen, the other degenerations consisted of: (1) A considerable degeneration of the most medially placed fibers in the pyramidal tract from the cortex of the left side; (2) some degeneration in the medial lemniscus of the right and to a much less degree of the left side; (3) degeneration in the lateral limb of the median longitudinal bundle of both sides; (4) a general degeneration of fibers that were superficially placed at the lower levels of the brain stem.

Case 2.—*History.*—A man, aged 43, who had had syphilis at the age of 18, was admitted to the Binghamton State Hospital, in 1911. He was despondent and feared that his soul was lost and that a terrible death awaited him. The memory was good. A diagnosis of "psychosis accompanying tabes" was made. A month after admission the patient lost the grasp of his surroundings, became indifferent and reticent. For a time he was resistive, and it was necessary to feed him with a spoon.

The pupils reacted slightly to light and in accommodation. There was a slight tremor of the tongue. The patellar reflexes were absent. There was some ataxia of the upper extremities. Speech was normal. The Wassermann reaction was negative.

In February, 1915, the patient developed paralysis of the left side. The pupils became contracted and rigid. There was flaccid paralysis of the left arm. The patellar reflex was absent on the left but was exaggerated on the right. The patient could not walk without assistance and then dragged the left foot. The tongue protruded to the left.

In May, 1915, examination showed a slurring of the test phrases. The pupils were small, without any reaction. The left side of the face and body was partially paralyzed. Left hemiplegia became more marked before death. The patient developed gastro-enteritis and died May 31, 1915.

Diagnosis.—The condition was diagnosed as psychosis accompanying cerebral syphilis.

Autopsy Report.—The dura was thickened and adherent; the pia was thickened and cloudy, especially over the left frontal tip, right frontal lobe, right sylvian fissure and right motor areas. There was probable softening in the right motor area in its lower three fourths. A coronal section showed a large softening involving the anterior half of the right internal capsule, most of the right lenticular nucleus and part of the caudate. There was another small softening in the white matter beneath the right angular gyrus. The heart was small; the right side was dilated and the left wall thickened; the mitral valves and the aortic cusps were thickened. The liver was yellow and soft. The gallbladder was distended with clear waterlike serum and contained from 25 to 30 yellow, newly formed stones. Microscopic examination revealed a thickened capsule, some fibrous tissue in Glisson's capsule and many fusiform cells. Some liver cells in the center of the lobules were beginning to break up; others contained fat vacuoles.

Lesion.—The right side only showed the lesion. It consisted of a large softening in the putamen and a second in the lateral segment of the globus pallidus (plate 2, fig. 11). The softening in the putamen included the ventral two thirds of the nucleus at its cephalic level, destroyed the anterior limb of the internal capsule at its upper level and extended into the body of the caudate nucleus. Caudally, it became narrowed and did not extend beyond the cephalic third of the putamen. Cephalad, the softening in the globus pallidus joined that in the putamen and destroyed the ventral half of the globus pallidus in its cephalic third. It then narrowed and extended caudad through the middle third of the lateral division of the globus pallidus to about the beginning of the caudal third of the nucleus. Small softened areas followed the course of the blood vessels throughout the entire caudal part of the putamen and to a slight degree in the globus pallidus.

Fiber Systems.—The brain stem was sectioned at an angle which inclined slightly more toward the coronal than the frontal plane, and consequently proved to be in many respects more advantageous for the study of the projection systems of the corpus striatum. From the area of the lesion in the globus pallidus, a great many fibers degenerated into both the fasciculus lenticularis of Forel (dorsal division of the ansa lenticularis of von Monakow) and the ansa lenticularis (ventral division of the ansa lenticularis of von Monakow). The fibers of the fasciculus lenticularis converged dorsocaudally, passed through the medial part of the basis pedunculi, thence in close relationship to the cephalic end of the subthalamic nucleus of Luys and took a position medial to that

nucleus and dorsomedial to the basis pedunculi (Forel's field H_2). Some fibers continued medial into the region above the column of the fornix and terminated. At a more caudal level, the fasciculus lenticularis was joined on its ventrolateral side by the ansa lenticularis, which arose for the most part from the ventral region of the globus pallidus, passed mediad in the medial and lateral medullary lamina, thence dorsomediad around the basis pedunculi to join the fasciculus lenticularis at about the level of the middle of the subthalamic nucleus of Luys. At this point, the fibers of the fasciculus lenticularis were directed caudad and somewhat mediad. The fibers of the ansa met those of the fasciculus lenticularis almost at a right angle and continued on through in a dorsal and somewhat lateral direction. These were joined by fibers from the fasciculus lenticularis, and together they formed a broad, fan-shaped layer of fibers directed, in general, dorsad. Most cephalically placed was a band of fibers that terminated in the substantia reticularis hypothalami between 2 and 3 mm. cephalad to the red nucleus. Lateral to this was a group that ran dorsad and slightly laterad to the lateral and more caudal part of the substantia reticularis hypothalami, ventral to the thalamus, and 1.5 to 2.5 mm. cephalad to the red nucleus. A large band of fibers ran dorsad and mediad, cephalad to the ventromedial side of the red nucleus, the most caudal fibers being in contact with the capsule of the nucleus. These inclined caudad to reach the region of the interstitial nucleus of Cajal, the nucleus of Darkschewitsch and the oculomotor nucleus. The remainder of the striate group left Forel's field H_2 dorsomediad to the basis pedunculi and ran for a short distance to terminate in a small area 0.5 to 2 mm. cephalad to the red nucleus and ventromediad to the area that would be occupied by the red nucleus. This area was just dorsolateral to the mammillothalamic fasciculus of Vic d'Azyr.

A great many fibers from the globus pallidus were degenerated dorsad through the internal capsule into the subthalamic nucleus of Luys. There was a considerable amount of shrinkage of the subthalamic nucleus in its cephalic part.

The fasciculus which made up a part of the lateral pes lemnisci and the one which terminated on the nuclei in relation to the lateral part of the substantia nigra each carried a large number of recently degenerated fibers. The plane of section being almost parallel with these as they passed through the basis pedunculi added greatly to the ease with which they might be traced. Moreover, these two fasciculi were distinctly separate in this case. (*a*) The fibers to the lateral pes lemnisci, arising in the globus pallidus, converged caudad and passed dorsad and slightly caudad through the basis pedunculi at the caudal level of the subthalamic nucleus of Luys, just lateral to the striate fibers which passed to that nucleus. Emerging from the basis pedunculi, they took a dorsolateral and caudal course through the substantia nigra. Continuing in this general direction, the fibers reached the ventrolateral part of the medial lemniscus at the cephalic level of the pons. Here they continued through the medial lemniscus and turned caudad in the ventrolateral part of the reticular formation. They could not be followed definitely to their termination. These fibers were identical with the fasciculus which in the cat was shown to continue caudad to the trochlear, abducens, masticator, facial, ambiguus and hypoglossal nuclei. (*b*) The second group of fibers passed through the basis pedunculi lateral to the fasciculus just described and continued dorsolaterad and caudad through the substantia nigra in a course parallel to the lateral pes lemnisci. There were scattered among these fibers many large nonpigmented cells on which most of them terminated. Shifting gradually dorsolaterad, the rest ended in the area ventrolateral to the medial lemniscus.

A large amount of degeneration had taken place in the pyramidal and some in the frontopontal tracts. There was also some degeneration in the median longitudinal fasciculus.

FIBER SYSTEMS AND DEGENERATIONS

REVIEW OF THE LITERATURE

Marchi,[4] in 1887, was the first to describe the small and medium sized cells with short axis cylinders in the caudate nucleus and putamen of mammals. The existence of large cells with long axis cylinders in mammals was perhaps first definitely proved by Cajal,[5] in 1895. Edinger,[6] Ariens Kappers,[7] de Vries,[8] de Lange [9] and others have demonstrated that the primordial basal ganglion of fish, reptiles and batrachians is homologous with the corpus striatum of mammals and that its cells give rise to the basal forebrain bundle. The forebrain bundle of Edinger links the paleostriatum in lower vertebrates to the optic thala- to have a close connection to the trigeminal system, both motor and sensory.

Forel [10] described his field H_2, which he believed to run forward and to terminate in the lenticular nucleus. Cajal [5] considers Forel's field H_2 as being composed of fibers derived from the internal capsule. He also describes collaterals from the fibers of the internal capsule entering the subthalamic nucleus of Luys. He recognizes fibers of striate origin also entering the subthalamic nucleus.

Dejerine [11] considers the ansa lenticularis as distinct from the internal capsule and continuing as far as the capsule of the red nucleus in man. He considers the principal contingents of the projection system

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4. Marchi: Sulla fina struttura dei corpi striati dei thalami optici, Riv. Sper. di freniat. 1887, vol. 12.

5. Cajal, S. P.: Histologie du système nerveux de l'homme et des vértébres, 1911, vol. 2, p. 505.

6. Edinger: Vorlesungen über den Bau der nervosen Centralorgane des Menschen und der Thiere, Leipzig, 1896.

7. Ariens Kappers, C. U.: Die Phylogenese des Rhinencephalons, des Corpus striatum und der Vorderhirncommissuren, Folia Neuro-Biologica. **1**:173, 1908; The Ontogenetic Development of the Striate Body of Birds and a Comparison with that of Mammals and of Man, Schweiz. Arch. f. Neurol. u. Psychiat., Festschrift f. Constantin von Monakow **13**:348, 1923; Reviewed in Arch. Neurol. & Psychiat. **12**:591 (Nov.) 1924.

8. DeVries: Das Corpus striatum der Säugetiere, Anat. Anzeig. **37**:385, 1910.

9. DeLange: L'évolution phylogénétique du corps strié, Le nevraxe, **14**: 105, 1913.

10. Forel, A.: Untersuchungen ueber die Haubenregion und ihre oberen Verknüpfungen im Gehirne des Menschen und einiger Säugethiere, mit Beitragen zu den Methoden der Gehirnuntersuchung, Arch. f. Psychiat. u. Nervenkrankh. **7**:393, 1887.

11. Dejerine, J.: Anatomie des centres nerveux, Paris, 1901

of the corpus striatum, however, to terminate in the subthalamic region and especially in Luys' body. He describes fibers from the cortex terminating in the lenticular nucleus—a connection that is not accepted by most authors.

Probst [12] and von Monakow [13] hold that the bundle of Forel is lenticular in origin and that it passes mesially and ventrally to the tuber cinereum, forming a fasciculus tuberis cinerei.

Dejerine [11] states that the commissure of Meynert is nothing more than a connection between the lenticular nuclei of the two sides. Cajal [5] believes that this commissure has a connection with the commissure of Gudden on the one hand and, on the other, with the group of cells which he calls the "perichiasmatique" nucleus. He quotes Darkschewitsch and Pribytkow as saying: "The Meynert's commissure acts as a unifying system for the corpus Luysi, the lenticular nucleus and the median island of Reil." O. Vogt [14] describes the commissure of Meynert as arising in the globus pallidus of one side and crossing to Luys' body of the opposite side.

Among the recent workers, Wilson and C. and O. Vogt have contributed most to the understanding of the fiber systems of the corpus striatum.

Wilson [15] placed electrical lesions in the corpus striatum of monkeys and studied the degenerations by the Marchi method. He finds: (1) Internuncial fibers; from the putamen to the globus pallidus, from the lateral to the mesial zone of the globus pallidus, and from the caudate to the putamen and globus pallidus (lateral zone); (2) striofugal fibers: to the capsule of the red nucleus, to the subthalamic nucleus of Luys, and to the locus niger. Wilson states that Meynert's commissure has no connection with the globus pallidus.

The fiber system of the corpus striatum, as given by the Vogts, is much more extensive than that of Wilson. According to C. and O. Vogt,[16] a group of fibers arising from the dorsal part of the globus pallidus crosses the ventrolateral nucleus of the thalamus and terminates in the region of the ventromedial nucleus. The main group of efferent fibers from the globus pallidus, constituting the ansa lenticularis, divide into a number of groups which terminate as follows: (1) in the ventro-

12. Probst, quoted by Wilson: An Experimental Research into the Anatomy and Physiology of the Corpus Striatum, Brain **36**:427, 1914.

13. Von Monakow, quoted by Wilson, (footnote 12).

14. Vogt, O.: Neurobiologische Arbeiten, 1904, p. 119.

15. Wilson, S. A. K.: An Experimental Research into the Anatomy and Physiology of the Corpus Striatum, Brain **36**:427, 1914.

16. Vogt, C., and Vogt, O.: Zur Lehre der Erkrankungen des Striärensystems, J. f. Psychol. u. Neurol., 1920, vol. 25.

medial nucleus of the thalamus, the nucleus of the tuber cinereum and the nucleus campi Foreli at a higher level; (2) in the ventromedial nucleus of the thalamus and nucleus campi Foreli at their more caudal level; (3) crossing through the decussation of Forel to the opposite side; (4) in the red nucleus of the same and opposite sides; (5) in the nucleus of Darkschewitsch and crossing through the posterior commissure to the interstitial nucleus of the opposite side. A group of fibers arises in the lateral division of the globus pallidus and terminates in the subthalamic nucleus of Luys and the substantia nigra. The Vogts show fibers taking origin in the nucleus campi Foreli, passing through Forel's field H_1, and terminating in the medial division of the globus pallidus. Another group of fibers arises in the ventromedial nucleus of the thalamus and the nucleus campi Foreli, passes through Forel's field H_2, and terminates in the globus pallidus, putamen and caudate nucleus. Fibers arising from the same region cross through the decussation of Forel to the pallidum of the opposite side.

Jakob [17] accepts the fiber connections of the striatum as given by the Vogts, with slight modifications. He believes that fibers end only in the nucleus of Darkschewitsch of the same and the opposite side but do not reach the interstitial nucleus of Cajal. He lays more emphasis on the connection with the substantia nigra and shows a bundle of fibers from the globus pallidus and substantia nigra which joins the lateral Hauben-fusschleife (lateral pes lemnisci) and crosses toward the midline, its termination not being known. He does not include the fibers which pass from the ventromedial nucleus of the thalamus and nucleus campi Foreli through the decussation of Forel to the opposite side.

Riese [18] describes fibers from the corpus striatum passing in the ansa lenticularis, Forel's field H_2 and the posterior longitudinal fasciculus, but he believes that the lateral pontile bundle arises from a level posterior to the pallidal region. He finds fibers from the striatum terminating in the substantia nigra and red nucleus.

Bickel [19] describes fibers descending from the striatum to the red nucleus, corpus Luysi, substantia nigra, nucleus of the posterior commissure and the nucleus of Darkschewitsch. He also states that there are secondary degenerations from the thalamus to the corpus striatum following lesions in monkeys.

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17. Jakob, A.: Die extrapyramidalen Erkrankungen, Berlin, 1923; reviewed by the author in Arch. Neurol. & Psychiat. **13**:596 (May) 1925.

18. Riese, W.: Beiträge zur Faseranatomie der Stammganglien, J. f. Psychol. u. Neurol. **31**:81, 1924.

19. Bickel, George: Syndrome des noyaux gris centrales, Rev. méd. de la Suisse, 1922, volumes 6 and 7; reviewed in Arch. Neurol. & Psychiat. **9**:219 (Feb.) 1923.

Sachs,[20] from a large series of lesions in the cortex, found fibers terminating in the ventral region of the lateral nucleus of the thalamus but no fibers running to the corpus striatum. Only lesions that involved the region of Forel's field gave degenerations to the globus pallidus.

Muskens,[21] from his so-called anatomicophysiologic method of investigation, postulates an ascending vestibular connection through the median longitudinal bundle and the posterior commissure to the commissural nuclei of the opposite side, thence to the subthalamic nucleus, anterior thalamic nucleus and corpus striatum. This is supported by two Marchi preparations of brains of cats: the first with the lesion in the vestibular nuclei, and the second with the lesion in the nucleus of the posterior commissure, the nucleus of Darkschewitsch and the interstitial nucleus. He also states that in cases showing a lesion in the globus pallidus he finds striofugal fibers to the nucleus interstitialis of Cajal and the nucleus of Darkschewitsch. He thinks it probable that the fibers which are described by Wilson as ending in the red nucleus terminate rather in the two nuclei anterior and medial to it.

Wilson [15] emphasized the fact that the efferent fibers of the globus pallidus are of fine caliber in comparison with that of the cortical fibers. This, in general, is true, but I have found in degenerations of fibers in the basis pedunculi following lesions in the cortex that a great many fine fibers pass down in the peduncle—fibers that could scarcely be separated from the striate fibers merely on the basis of size. In this work, I have checked my material with striate lesions against Marchi preparations in which large lesions had been placed in the frontal and parietal cortex. It is true, however, that the efferent fibers of the globus pallidus are of fine caliber and particularly those fibers which have been described as terminating in the dorsal part of the substantia reticularis hypothalami, subthalamic nucleus of Luys, and the cells in the lateral part of the substantia nigra designated by Malone [22] as the small cells of the substantia nigra and later as the nucleus intrapeduncularis.

RESULTS OF THIS INVESTIGATION

The group of fibers which passes through Forel's field H_2 to terminate in the nucleus mammillo-infundibularis of Malone and the ventral medial part of the substantia reticularis hypothalami are of a coarser

20. Sachs, Ernest: On the Structure and Functional Relations of the Optic Thalamus, Brain **32**:95, 1909.

21. Muskens, L. J. J.: The Central Connections of the Vestibular Nuclei with the Corpus Striatum and Their Significance for Ocular Movements and for Locomotion, Brain **45**:454, 1922.

22. Malone, E.: Ueber die Kerne des menschlichen Diencephalon, aus dem Anhang zu den Abhandlungen der königl., Preuss. Akad. d. Wiss., 1910.

nature. Those which pass through the medial lemniscus and continue down to the motor nuclei of the midbrain and medulla belong to this coarser type.

Since in the cat the efferent fibers are so small in caliber, run in diffusely scattered bands and so frequently are directed obliquely to the frontal plane of the section, it is difficult to make an absolute count of the number of degenerated fibers in each case. This is especially true of that group of fibers which terminates in the caudal part of the substantia reticularis hypothalami and the subthalamic nucleus of Luys. Hence, the approximate number of degenerated fibers given under the description of various cases may be taken only as an estimate.

In the cat, the medial division of the globus pallidus is oval in form and is completely embedded within the cerebral peduncle. The projection system of the globus pallidus, as it passes through the cerebral peduncle, forms a single large unbroken field of fibers, the various constituents of which can not be separated. The tendency for these fibers to be more concentrated at the base of the peduncle and again at the lateral side of the subthalamic nucleus of Luys is the only similarity to that definite grouping of fibers in man which results in the formation of the fasciculus lenticularis of Forel and the ansa lenticularis. In man, all fibers that terminate in the subthalamic nuclei, interstitial nucleus and oculomotor nucleus pass through these two definite fasciculi.

Striate Fibers to the Region of the Posterior Commissure and Subthalamic Region.—In the cat: There are degenerations in the cat, following lesions in the globus pallidus, to the nucleus mammillo-infundibularis (Malone), to the substantia reticularis hypothalami, the subthalamic region ventrocaudal to the thalamus, the interstitial nucleus of Cajal, the nucleus of Darkschewitsch, the oculomotor nucleus, the nucleus of Westphal-Edinger, the red nucleus, the subthalamic nucleus of Luys, the large unpigmented cells of the substantia nigra, the lateral part of the nucleus peripeduncularis lateralis of Jacobsohn, through the supermammillary commissure to the ventromedial region of the substantia reticularis hypothalami of the opposite side and through Meynert's commissure to the globus pallidus and the region of Forel's field H_2 of the opposite side.

1. A group of fibers, somewhat coarser in texture than most of those which arise in the globus pallidus in the cat, passes through the basal third of the cerebral peduncle and turns mediad at Forel's field H_2. These pass through the peduncle at a level cephalad to the subthalamic nucleus of Luys. A small fasciculus of these fibers describes a curve medially above the column of the fornix and terminates just medial to

the fornix. Winkler and Potter [23] call this area the nucleus infundibularis anterior. Malone [22] designates it in man as the nucleus mammillo-infundibularis, and later states that it is homologous to a similar nucleus in the cat and monkey.

Scattered among the fibers of Forel's field H_2 in the cat are large cells which correspond somewhat to Cajal's nucleus of the internal capsule, as he described it in the rabbit, cat and mouse. In man, however, Forel's field H_2 is dense with fibers, and the cells have been pushed into the medial zone of the field. Malone does not recognize a nucleus of the internal capsule but identifies these cells in man as cells chiefly of the nucleus mammillo-infundibularis, with the addition of a few cells of the substantia reticularis hypothalami which have scattered through this field from the main nuclear mass lying more dorsad. Many of the degenerated fibers of Forel's field H_2 terminate on these cells. The remaining fibers continue caudad in this field for a short distance and then terminate in the ventromedial region of the substantia reticularis hypothalami and the region surrounding the mammillothalamic fasciculus of Vicq d'Azyr. This region, according to Winkler and Potter, in their plate XII, would consist of the ventromedial cells of the nucleus hypothalamus lateralis, and the region surrounding Vicq d'Azyr's bundle would be made up, for the most part at least, of their nucleus infundibularis anterior. According to Malone, this region contains cells of the substantia reticularis hypothalami, among which are scattered cells of the nucleus mammillo-infundibularis (plate 5). Some degenerated fibers cross in the supramammillary commissure and terminate in the same region of the opposite side.

In cat 444, there were approximately 4,000 or 5,000 degenerated fibers in this field. The lateral division of the globus pallidus was destroyed in its ventral half, and approximately one third of the medial division was injured.

In cat 471, there were approximately 2,500 or 3,000 degenerated fibers in this group. There was complete destruction of the lateral division of the globus pallidus with only slight injury to the medial division.

In cat 448, less than 1,000 fibers were degenerated in this field. The lesion destroyed all the lateral division of the globus pallidus in its middle part but only the dorsal tip of this division at the caudal level.

It seems, on a comparison of the cases described, that most of the fibers of this group arise from the cells of the medial division of the globus pallidus. This is in accordance with the human brain in case 1. It might be roughly estimated that this fasciculus of the globus pallidus in the cat carries a total of 8,000 or 9,000 fibers.

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23. Winkler, C., and Potter, Ada: An Anatomical Guide to Experimental Researches on the Cat's Brain, Amsterdam, W. Versluys, 1914.

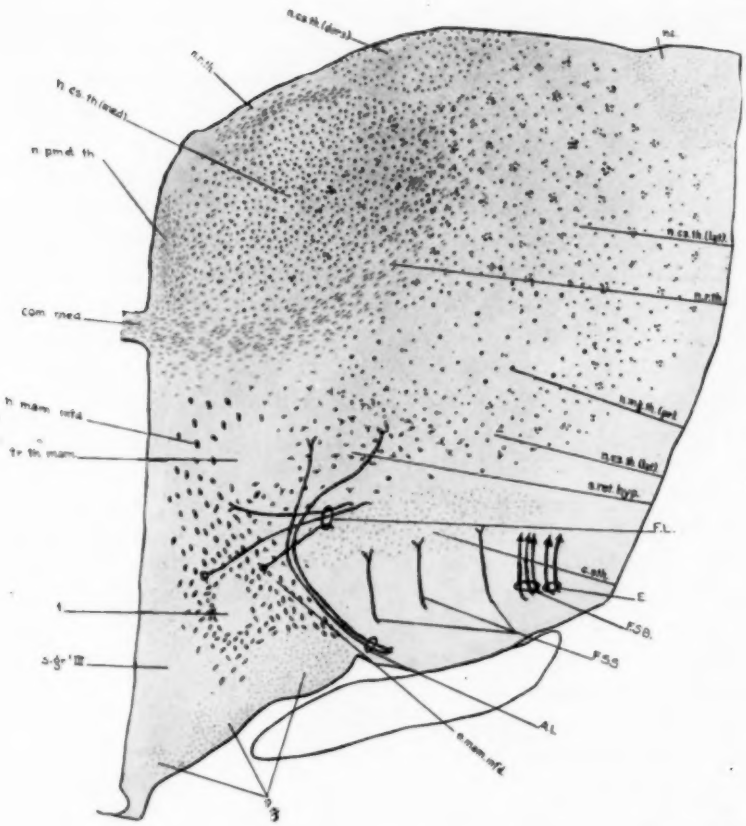

Plate 5 (fig. 1).—Schema (based on Malone's figures of nuclei of the human diencephalon) showing the termination of fibers from the corpus striatum in the subthalamic region and the region of the posterior commissure in man; *n. mam. infd.* indicates nucleus mammilo-infundibularis; *s. ret. hyp,* substantia reticularis hypothalami; *c. sth,* corpus subthalamicum; *n. c.p.,* nucleus of the posterior commissure; *n. oc.,* oculomotor nucleus; *s. n.,* sensory division of the substantia nigra; *s. n',* motor division of the substantia nigra (intrapeduncularis); *n pped. (lat),* lateral peripeduncular nucleus; *F. L.,* fasciculus lenticularis of Forel; *A. L.,* ansa lenticularis; *F. S. B.,* striobulbar fasciculus; *E,* fasciculus to intrapeduncular nucleus and lateral peripeduncular nucleus of Jakobsohn; *F. S. S.,* striosubthalamic fasciculus; *F. S. T.,* fasciculus striotegmental (to interstitial, Darkschewitsch's oculomotor, and Edinger-Westphal's nuclei). An explanation of the nuclei of the thalamus is given by Malone (references 22 and 24 in the text).

2. Following lesions in the globus pallidus in the cat, a great many fine degenerations pass obliquely dorsocaudad through the basal third of the cerebral peduncle, thence dorsad through the lateral part of Forel's field H_2 and the zona incerta, into the cephalic part of Forel's field H. These fibers then turn caudad and terminate in that field. This region corresponds, no doubt, to the nucleus campi Foreli of the Vogts and to the nucleus of Forel's field of some authors. It is the interstitial

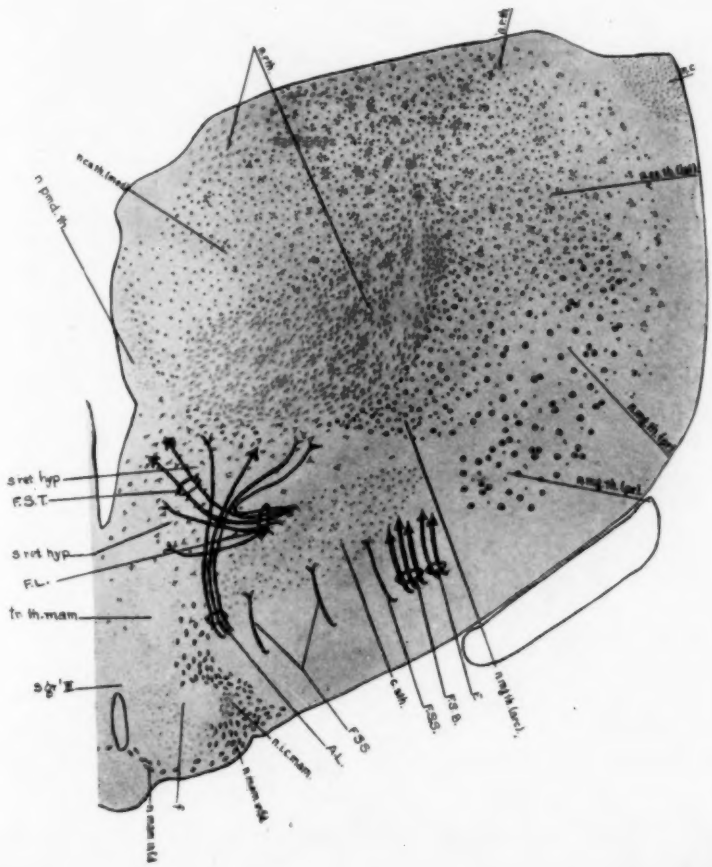

Plate 5 (fig. 2).—Schema based on a section cephalad to the red nucleus (fig. 1).

nucleus of Forel's field described by Cajal. Winkler and Potter, in their plate XII, refer to the nucleus in this region as the lateral hypothalamic nucleus (*hb*). Malone [22] describes it as the substantia reticularis hypothalami, (plate 5) and in a later paper [24] states that this nucleus is present in the cat, monkey and in man. He also points out that the cells of the nucleus are of a motor type.

In cat 444, in which the lesion involved the ventral part of the lateral division of the globus pallidus and about one third of the ventral division, there were approximately 4,500 or 5,000 degenerated fibers in this group. In cat 471 there were approximately 2,000 degenerated fibers, with about 1,000 in cat 448. This comparison suggests the probability that these fibers arise largely from the medial division of the globus pallidus and the ventral part of the lateral division. This

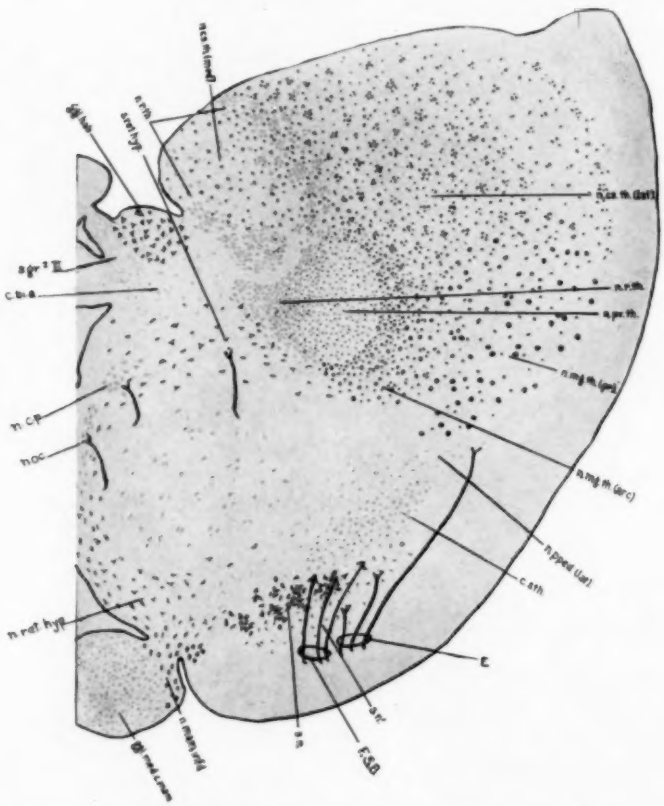

Plate 5 (fig. 3).—Schema showing striate fibers at the level of the red nucleus (fig. 1).

fasciculus may be roughly estimated to carry a total of 9,000 or 10,000 fibers in the cat.

3. A great many fine degenerations pass through the basal half of the cerebral peduncle and enter directly into the subthalamic nucleus of Luys. This nucleus is well known, as well as its connection to the globus pallidus. It is difficult to estimate the number of fibers which enter this nucleus, since they form a large field and are running almost parallel to the plane of section. It is apparent, however, that the strio-

hypothalamic fasciculus is one of the largest of the fasciculi that arise in the globus pallidus. It also seems probable that these fibers arise from all part of the globus pallidus and have no tendency to arise from the cells of any special region.

4. A broad field of fine degenerations passes obliquely caudad through the basal half of the internal capsule in close relationship to the inferior end of the subthalamic nucleus of Luys and continues directly into the region ventral and caudal to the thalamus. The majority of these fibers terminate in the subthalamus. Their termination in the cat is in the region cephalolaterad to the red nucleus. This region is bounded dorsad and cephalad by the thalamus and caudad by the red nucleus and the reticular formation. It is a caudal continuation of Forel's field. Malone describes his substantia reticularis hypothalami as continuing back in this region beyond the cephalic region of the red nucleus (plate 5). The nuclei in this region should, no doubt, be considered as a part of the subthalamus and not as pertaining to the thalamus proper.

A considerable number of fibers continue beyond the subthalamic region. For this group, the name striotegmental fasciculus is suggested. They pass obliquely dorsomediad in front of and dorsal to the red nucleus. The majority of them terminate immediately in the interstitial nucleus of Cajal, while a few pass into the nucleus of the posterior commissure of Darkschewitsch. The remainder continue caudad to the oculomotor nucleus and the nucleus of Westphal-Edinger. A few fibers run among the most cephalic scattered cells of the red nucleus and terminate. Only in cat 444 is there a definite indication of fibers crossing with the posterior commissure to terminate in the interstitial nucleus and perhaps the nucleus of Darkschewitsch of the opposite side.

Since this group of fibers runs almost parallel to the frontal plane of section, it is impossible to estimate with any great degree of accuracy the number of fibers constituting this fasciculus. It may only be said that this group approaches in number that of the striosubthalamic fasciculus. Since the fibers which enter the red nucleus pass only among the most cephalic scattered cells, I am unable to state with absolute certainty that they terminate on the cells of that nucleus. It can be said, however, that in none of my preparations am I able to demonstrate a connection between the globus pallidus and the red nucleus which in any way merits the importance given to this connection by Wilson and his followers.

5. A large fasciculus of fine fibers moves outwardly along the ventral surface of the cerebral peduncle in the cat to its lateral third. These fibers pass obliquely through this region of the peduncle and take a position on its dorsal side at the cephalic level of the substantia nigra. In this region there appears, in the cat, a nucleus somewhat rounded in

cross section and elongated cephalocaudally from the upper level of the substantia nigra to the caudal level of the midbrain. The nucleus is, in its cephalic part, partly buried within the lateral third of the cerebral peduncle. The fasciculus from the globus pallidus takes its position among and surrounding this group of cells and follows it caudad. As this fasciculus and its nucleus move caudad they become separated from the cerebral peduncle and shift laterad and somewhat dorsad. The nucleus contains fewer cells at these lower levels. The degenerated fibers gradually terminate on these cells and their place is taken by an undegenerated fasciculus. A considerable number of the degenerated fibers continue beyond this nucleus and scatter diffusely through a triangular region ventrolateral to the medial lemniscus and suddenly end on the small cells of that region. The elongated nucleus on which the majority of these fibers terminate is shown by Winkler and Potter [23] in their plate XV. In this diagram, it is labeled on the left side as substantia nigra. On the right side, it consists of the large cells buried in the lateral part of the cerebral peduncle ventral to the region designated as the corpus subthalamicum. In plate XVI the nucleus is still shown, apparently as part of the substantia nigra. In plate XVII, however, it is illustrated in the position which it assumes at a more caudal level and seems to be distinct from the substantia nigra both as to topography and as to the character of its cells. The cells of this nucleus are illustrated as being larger than any of those of the surrounding region, but are unlabeled. These are undoubtedly the cells which Malone [24] describes in the cat, monkey and man and for which he suggests the name nucleus intrapeduncularis because of their close relationship to the cerebral peduncle. He points out that this group of cells, previously considered a part of the substantia nigra, are distinct in character from the remaining cells of that nucleus. The nucleus intrapeduncularis is composed, according to Malone, of cells which are distinctly of a motor type, whereas the other cells of the substantia nigra, pigmented in man, are distinguished by their structure as being sensory in function. He describes these cells in man as taking a position in the ventral and lateral sides of the substantia nigra in its oral part. The elongated nucleus which runs along the lateral side of the substantia nigra in the cat is composed of cells that differ in character from those of the remainder of that nucleus, and correspond, no doubt, to the motor cells described by Malone in man and designated by him as the nucleus intrapeduncularis. The cells, ventrolateral to the medial lemniscus at the lower level

24. Malone, E.: Observations Concerning the Comparative Anatomy of the Diencephalon, Anat. Rec. **6**:281, 1912; Recognition of Members of the Somatic Motor Chain of Nerve Cells by Means of a Fundamental Type of Cell Structure, and the Distribution of such Cells in Certain Regions of the Mammalian Brain, Anat. Rec. **7**:67, 1913.

of the midbrain, on which the remainder of the degenerated fibers from the globus pallidus terminate, apparently belong to the lateral peripeduncular nucleus of Jacobsohn. The fibers of this fasciculus seem to arise largely from the medial division and ventral part of the lateral division of the globus pallidus. It is estimated to be larger than any other fasciculus which arises in the globus pallidus and probably carries more than 12,000 fibers.

5. Meynert's commissure has carried a considerable amount of degeneration in every case in which there is injury to the medial division or to the ventral part of the lateral division of the globus pallidus. This degeneration seems sufficiently great to justify the conclusion that Meynert's commissure is composed of fibers which arise from the medial division and the ventral part of the lateral division of the globus pallidus, cross the midline dorsal to the commissure of Gudden, and break up into two parts. The major part terminates in the globus pallidus of the opposite side. The minor division, consisting of a few fibers, turns dorsolaterad and caudad, passes above or sometimes through the column of the fornix and is lost in the medial side of Forel's field H_2. Apparently these fibers terminate on some of the cells in that region, belonging either to the substantia reticularis hypothalami or to the mammillo-infundibularis, or to both.

In Man: There is a tendency in man for the fiber systems already described, which terminate in the mammillo-infundibular nucleus, the substantia reticularis hypothalami, the interstitial nucleus of Cajal, the nucleus of Darkschewitsch, the oculomotor nucleus, and the red nucleus, to collect into two distinct fasciculi—the fasciculus lenticularis of Forel and the ansa lenticularis. This system of fibers will be dealt with as a unit. It is shown diagrammatically in plate 5, Malone's figures of nuclei of the human brain stem being used as a basis for the schema.

The fasciculus lenticularis of Forel, in man, leaves the globus pallidus in its caudal part and passes through the basal part of the cerebral peduncle in close relationship to the cephalic end of the subthalamic nucleus of Luys, part of the fibers entering into the formation of the capsule of that nucleus. This fasciculus then turns mediad above the basal side of the peduncle, forming Forel's field H_2. Some of these fibers terminate in the nucleus mammillo-infundibularis (nucleus infundibularis anterior). Cells from this nucleus invade the medial part of Forel's field H_2, and some fibers from the globus pallidus terminate on them. The majority of the fibers from the globus pallidus continue caudad in Forel's field H_2. The ansa lenticularis is composed of fibers which for the most part arise from the ventral region of the globus pallidus and pass mediad in the medial and lateral medullary lamina. These fibers then continue dorsomediad around the basis pedunculi and join the fasciculus lenticularis at about the level of the

middle of the subthalamic nucleus of Luys. The fibers of the ansa, for the most part, continue directly through Forel's field H_2 carrying with them fibers from that field. These form a broad, fan-shaped layer directed, in general, dorsad. A band of the most cephalically placed fibers terminate in the medial part of the substantia reticularis hypothalami (nucleus of Forel's field), between 2 and 3 mm. cephalad to the level of the red nucleus. Lateral to this, a group turns slightly laterad into the region ventrocaudal to the thalamus at a level between 1.5 and 2.5 mm. cephalad to the red nucleus, and terminates in the caudal and lateral parts of the substantia reticularis hypothalami. The most caudal of these fibers leave the region of Forel's field H_2, forming a large band which runs dorsad and mediad immediately in front of the red nucleus. Some of these are in contact with the capsule of the red nucleus and perhaps terminate in that nucleus. The greater part of the fasciculus continues into the region of the interstitial nucleus of Cajal, and the nucleus of Darkschewitsch. One may conclude, on the basis of the degenerations found in cats following lesions in the corpus striatum, that these fibers terminate in the interstitial nucleus, nucleus of Darkschewitsch, oculomotor nucleus and nucleus of Westphal-Edinger. It was also shown by Marchi preparations in the cat that fibers from the globus pallidus cross through the supramammillary commissure to the region of the substantia reticularis hypothalami of the opposite side, to the oculomotor nucleus of the opposite side and perhaps through the posterior commissure to the interstitial nucleus and the nucleus of Darkschewitsch of the opposite side. Many fibers continue caudad in Forel's field H_2 and terminate in the region ventromedial to the substantia reticularis hypothalami and the region dorsomedial to the mammillothalamic fasciculus, probably on cells of both substantia reticularis hypothalami and the nucleus mammillo-infundibularis (Malone).

The manner in which fibers from the globus pallidus pass directly through the cerebral peduncle into the subthalamic nucleus of Luys as many small fasciculi is well known and need not be elaborated on.

Fibers from the globus pallidus pass obliquely through the cerebral peduncle somewhat lateral to the subthalamic nucleus of Luys and emerge among the small nonpigmented cells of the substantia nigra (the intrapeduncular nucleus of Malone). Some of these terminate immediately in this nucleus. A considerable group, however, take a caudal and somewhat dorsolateral course through the most laterally placed small motor cells of the substantia nigra. Most of them terminate within this nucleus, but some continue into the region ventrolateral to the medial lemniscus at the most caudal level of the midbrain and terminate on cells of that region. The latter group of cells probably belong to the peripeduncular nucleus of Jacobsohn.

The superior commissure of Meynert is present in man as well as in the cat. The two human brain stems described in this paper do not yield any information concerning this commissure. On the basis of Marchi preparations in the cat, I have already shown that the fibers of this commissure arise in the globus pallidus and terminate, for the most part, in the globus pallidus of the opposite side, while a few turn more dorsad and caudad into the region medial to Forel's field H_2.

Striofugal Fibers to the Motor Nuclei of the Midbrain, Pons and Medulla.—In the Cat: Fibers from the globus pallidus have been shown to terminate in the trochlear, abducens, masticator, facial, ambiguus and hypoglossal nuclei of the same and opposite sides, and some continue below this level in the median longitudinal fasciculus. Since these fibers compose a fasciculus which joins, and to a large degree at least are distributed with, the lateral corticobulbar tract, I should like to suggest that it be called the lateral striobulbar fasciculus. Arising apparently in the dorsal part and especially from the lateral division of the globus pallidus, these fibers pass obliquely dorsocaudad through the cerebral peduncle at a point lateral to the subthalamic nucleus of Luys. They are somewhat larger than most of the fibers which terminate in the subthalamic region. They resemble, rather, the striate fibers which pass through Forel's field H_2 and terminate in the mammillo-infundibular nucleus and substantia reticularis hypothalami. Emerging from the cerebral peduncle, they continue obliquely dorsocaudad and laterad through the substantia nigra, as a fairly constricted band. At the lower level of the midbrain and upper level of the pons, they join the medial lemniscus in its ventrolateral part, shift gradually through the lemniscus, turn caudad and come to occupy a field of considerable extent in the ventrolateral part of the reticular formation. In this position, the fasciculus is bounded laterally by the lateral lemniscus and ventrally by the medial lemniscus. These fibers continue caudad in this position until they become displaced dorsally by the superior olivary nucleus, and at the anterior level of that nucleus they occupy the same area as the rubrospinal tract. The dorsal fibers of this fasciculus continue directly into the masticator nucleus. Those more ventrally placed terminate in the facial and ambiguus nuclei.

The fibers of the group that I have already described pass through the medial lemniscus at the highest level and continue dorsomediad through the reticular formation to the trochlear and abducens nuclei. Others leave the striobulbar fasciculus throughout its course in the pons and find their way singly or in small isolated groups through the reticular formation and reach a point lateral to the median longi-

tudinal fasciculus. This group of fibers, at the lower level of the pons, moves mediad and joins the median longitudinal fasciculus. Some of them cross to the opposite side. The majority continue caudad in the median longitudinal fasciculus and terminate in the hypoglossal nuclei. Some continue beyond this level in the median longitudinal fasciculus, but their termination cannot be ascertained. In the region of the pons, the striobulbar fasciculus gives off a considerable number of fibers which cross with the brachium conjunctivum to the opposite side. This contralateral division takes the same position and apparently terminates in the same manner as the homolateral division.

The lateral striobulbar fasciculus, at the cephalic level of the pons, is estimated to carry from 4,500 to 5,000 fibers. Cephalad to the masticator nucleus, the fasciculus carries perhaps 2,000 or more fibers. The fibers which leave the fasciculus to cross to the opposite side and to terminate in the trochlear, abducens and hypoglossal nuclei are not sufficient to account for the rapid diminution in the lateral striobulbar fasciculus in its course through the pons. This suggests the probability that some of the fibers of this fasciculus terminate on the reticular nuclei of the pons and oblongata.

The Lateral Striobulbar Fasciculus in Man: I described this fasciculus in a paper read before the American Association of Anatomists in April, 1925. The fasciculus in man has since been found to correspond in course and distribution to that demonstrated by the Marchi method after degeneration in the cat. The lateral striobulbar fasciculus has been described in the human brain stem in case 1 in this paper (plate 6).

SYMPTOMATOLOGY FOLLOWING LESIONS OF THE CORPUS STRIATUM

REVIEW OF THE LITERATURE

Practically all of the early work done on the corpus striatum of a physiologic and clinical nature has been extensively reviewed by C. and O. Vogt,[16] Bechterew,[25] Luciani,[26] Dana,[27] Wilson,[15] Jakob,[17] Tilney and Riley[28] and others. It seems unnecessary to include a complete review of this literature except as it has a direct bearing on the topics discussed.

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25. Bechterew: Die Funktionen der Nervenzentra, Jena, 1909.

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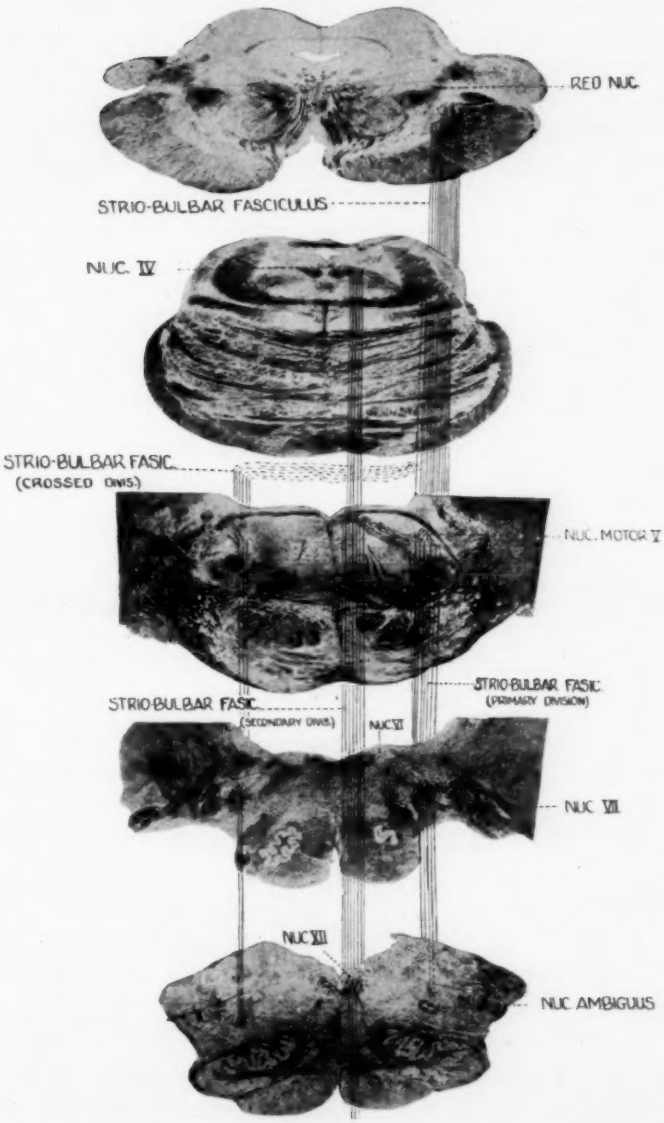

Plate 6.—Schema (constructed from figures by Rauber and Kopsche) illustrating the course and distribution of the striobulbar fasciculus.

Fibers are shown terminating in the trochlear nucleus *(NUC. IV)*, the masticator nucleus, *(NUC. MOTOR V)*, the abducens nucleus *(NUC. VI)*, facial nuclei (*NUC. VII*), hypoglossal nuclei (*NUC. XII*), and ambiguus nuclei *(NUC. AMBIGUUS)*.

Among the more recent experimental workers, Kalischer,[29] Rogers,[30] Wilson,[15] Mella,[31] Lashley,[32] Edwards and Bagg,[33] Muskens,[34] and others have contributed to the knowledge concerning the functions of the corpus striatum.

C. and O. Vogt,[16] Wilson,[2] Jakob,[18] Ramsay Hunt,[35] Lhermitte,[36] Lewy,[37] Foerster,[38] and others have added greatly to the knowledge of the clinical syndromes of the corpus striatum. Among the most common symptoms accompanying degenerative changes in the corpus striatum are rigidity, tremor, torsion spasms, athetosis, paralysis agitans, dysarthria and dysphagia.

Wilson's progressive lenticular degeneration is one of the best known diseases of the corpus striatum. Hall[39] summarizes sixty-eight cases of lenticular degeneration including pseudosclerosis. Of this number, fifty-nine cases showed defects in speech; twelve, difficulties of deglu-

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29. Kalischer, Otto: Das Grosshrin der Papegeien in anatomischer und physiologischer Beziehung, aus dem Anhang zu den Abhandlungen der Königl. Preuss. Akad. d. Wiss., 1905, p. 105.

30. Rogers, F. T.: Studies of the Brain Stem. VI. An Experimental Study of the Corpus Striatum of the Pigeon as Related to Various Types of Instinctive Behavior, J. Comp. Neurol. **35**:21, 1922; An Experimental Study of the Cerebral Physiology of the Virginia Opossum, J. Comp. Neurol. **37**:265, 1924.

31. Mella, Hugo: The Diencephalic Centers Controlling Associated Locomotor Movements, Arch. Neurol. & Psychiat. **10**:141 (Aug.) 1923.

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35. Hunt, J. R.: Progressive Atrophy of the Globus Pallidus, Brain **40**: 58, 1917.

36. Lhermitte, J.: The Anatomical and Clinical Syndromes of the Corpus Striatum, Neurol. Bull. **3**:163, 1921; reviewed in Arch. Neurol. & Psychiat. **6**:684 (Dec.) 1921.

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38. Foerster, O.: Zur Analyse und Pathophysiologie der striären Bewegungsstörungen, Ztschr. f. d. ges. Neurol. u. Psychiat. **73**:1 (Dec.) 1921.

39. Hall, H. C.: Dègenéréscence hepató-lenticulaire, Paris, 1921.

tition; seventeen, salivation; sixty-five, tremor; twenty-three reached advanced stages of rigidity; thirty-three showed athetosis, chorea and contractures or tonic spasms; hypertonia was present in twelve cases.

RESULTS OF THIS INVESTIGATION

My lesions in the corpus striatum of the cat were frequently followed by characteristic circus movements, difficulty in taking food, chewing and swallowing, voice disturbance, hypertonicity, tremor, athetoid movements and constriction of the pupil.

Circus Movements.—Of the six animals described in this paper, three exhibited rotation toward the injured side, one to the contralateral side, while another alternated—sometimes turning to the right and at other times to the left.

In the characteristic rotation to the injured side, circus movements commence instantaneously and terminate in the same manner. They are more frequent from two to six days following the operation and are more apt to occur when the animal is striving to reach food or making some voluntary effort. In starting toward food that is placed at some distance, the animal might suddenly stop and make a number of rotations in rapid succession, continue on its way, and perhaps have two or three such seizures before reaching its original destination. While feeding, it might frequently stop and make a few rapid circus movements toward the injured side. It is characteristic of these movements that the animal apparently has its attention focused on a definite goal, and the circus movements do not seem to interfere with the original purpose but only with the ability to carry it out. It is as if the animal's voluntary motor system were bent on accomplishing a certain act when some subcortical center temporarily interferes with that act by producing a movement that is involuntary and automatic.

Three elements seem to be involved in the circus movements: (1) a tendency to turn toward the side of the lesion; (2) hypertonicity of the muscles of the injured side, and (3) automatic walking movements.

Kalischer pointed out that the initiation of circus movements arises in one region, while the motivation of these movements depended on another center. Muskens showed that circus movements to the injured side may be caused by lesions in the corpus striatum or in the commissural nuclei or any point which would break the connection between the two regions. Mella has shown the presence of a mechanism at the level of the subthalamic nucleus and globus pallidus for associated automatic walking movements. It seems possible that the circus movements are initiated through the fiber system connecting the globus pallidus with the interstitial nucleus and perhaps the nucleus of Darkschewitsch. These nuclei have been shown by Cajal and others to receive fibers from the superior colliculus and also to have a connection

with the vestibular mechanism through the median longitudinal bundle, while Boyce has described an interstitiospinal tract continuing down into the spinal cord. A disturbance of this mechanism produces rolling movements as well as circus movements. It is probable that the globus pallidus, through the fiber connection which it has been shown to have with the interstitial nucleus and the nucleus of Darkschewitsch, is able to effect the turning of an animal to one side or the other. However, it seems likely that the automatic associated walking movements are carried out by still another mechanism on which the corpus striatum also exercises some control.

It will be noted that circus movements as well as the hypertonic condition of the muscles appear only during the first few days. During this period, they appear and disappear spontaneously and vary considerably as to duration. This suggests the probability that these are irritation symptoms rather than movements occurring because of a deficiency of the corpus striatum.

Rotation to the side opposite the injury was shown in cat 471 to be of a different character than rotation to the injured side. In this contralateral rotation the movements were similar, but the attitude was somewhat different. The entire attention of the animal was distracted from its surroundings and focused as on some imaginary point which it was striving to reach. In other words, it was as if the cat was in a hypnotic trance. Its attention could not be attracted by any means, and sometimes the circus movements continued for several minutes. When they ceased it had apparently lost all grasp of its surroundings and must put forth an effort to orient itself. Circus movements to the side opposite the injury were also characterized by an extremely hypertonic condition of the side of the body toward which the animal was rotating. These circus movements were no doubt initiated within the cerebral cortex rather than in the corpus striatum. It was noted that there was, in the two animals which rotated to the side opposite the lesion, a great deal of injury to the thalamocortical radiations, and in cat 471 there was additional injury to the optic radiations.

Hypertonia.—With the possible exception of cats 420 and 445, all the animals operated on were characterized by a restless, hypertonic condition. The muscles of the body seemed tense and alert. The animals maintained almost constant motion. The muscles of the legs were usually spastic and tense; the muscles of the neck and shoulders were more hypertonic than those of the remainder of the body, and the forelegs more hypertonic than the hindlegs. The hypertonicity was more evident at some times than at others and disappeared from six to ten days after the operation. During circus movements, it became extreme in the muscles of the neck and body on the side toward which the animal turned. When the hypertonic condition ceased at the end

of a few days, the animal relaxed completely; the restless movements disappeared, and there was to all appearances a complete recovery of normal function, with, however, some weakness and loss of tone in the muscles.

Athetoid Movements.—Among the animals in which a lesion was placed in the corpus striatum, only one showed pronounced athetoid movements, while a second showed movements suggesting athetosis. These movements were characterized by an alternate raising of the front feet; as the foot was raised, the ankle and toes were flexed in a grasping manner; as the foot was lowered, the ankle was extended and the toes extended and spread widely apart. These movements were executed with a slow rhythm. The former, cat 471, had, in addition to a large lesion in the corpus striatum, considerable injury to the thalamocortical and optic radiations. Cat 444, which sometimes alternately raised and lowered the front feet in a manner nearly approaching athetoid movements, had practically no injury to the cortical fibers. In the first animal, there was slight injury to the medial division of the globus pallidus, while in the second, about one third of this division was destroyed. These are the only two cases in which the medial division of the globus pallidus was injured.

In three cats in which the parietal cortex was extirpated, there were marked athetoid movements, being more pronounced on the side opposite the lesion. In two of these animals, the symptoms disappeared after a few days; in the third, in which there developed a degeneration in both the medial and lateral divisions of the globus pallidus, they began rather mildly and increased in severity until the animal was killed ten days after the operation. These facts seem to indicate that athetoid movements may have their origin either in the cortex or within the medial division of the globus pallidus. In the case in which there was no injury to the internal capsule but a fairly large lesion in the medial division of the globus pallidus, the symptoms were mild, if indeed they could be called athetoid movements at all. The case in which there was slight injury to the medial division of the globus pallidus and also the thalamocortical radiations was characterized by severe athetosis, as was also the case in which there was a lesion in the parietal area of the cortex and also degeneration within both divisions of the globus pallidus.

Tremor.—Cats 444 and 434 exhibited a fairly coarse tremor, particularly of the head and neck. This symptom disappeared within a few hours following the operation. Cat 471, which manifested both right and left circus movements and athetosis, also showed a tremor which persisted for about eight days. This tremor accompanied the athetoid movements, affecting the forelegs, head and neck. It was also more pronounced during feeding. When the animal attempted to

eat the head jerked spasmodically at brief intervals, and a fairly coarse tremor passed over the neck and body. It will be recalled that in this animal there was complete destruction of the putamen and the lateral division of the globus pallidus with some injury to the medial division of the globus pallidus and considerable to the thalamocortical and optic radiations.

Pupillary Constriction and Disturbance of the Eyes.—Cats 444, 471 and 445 manifested a marked constriction of the pupil on the injured side, while in cat 448 there was marked dilatation of the pupil on the injured side when the lesion was placed. In the former cases, the pupils remained constricted until the animals were killed, but in the latter case, following the short period of dilatation the pupil was observed at various times to change rapidly in size, growing sometimes smaller than the other pupil and sometimes larger. This was a quick, somewhat spasmodic contraction or dilation.

In only two of the cases was there injury to the optic tract. In the three cases that showed constriction of the pupil, the lesion extended into the ventral part of the globus pallidus. In the remaining cases, including the one which manifested rapid change in size of the pupil, the ventral part of the globus pallidus was free from injury in its more caudal end.

The only suggestion of defective movements of the eyes was a constant restless shifting of the eyes in those cats which revealed a similar condition in all bodily movements.

It is evident that the corpus striatum exercises some influence over movements of the eyes and especially the reactions of the pupils. This is made possible by the efferent fiber systems from the globus pallidus which terminate in the oculomotor, trochlear, and abducens nuclei and the nucleus of Westphal-Edinger.

Defective Feeding Movements and Disturbances of the Voice.—In all of the cats in which a lesion was placed in the corpus striatum, with the possible exception of cat 444, there was pronounced disturbance of the feeding mechanism. For a few days following the operation, this disturbance seemed to be caused largely by spasticity or hypertonicity of the muscles of mastication, of swallowing and the muscles of the tongue. Among the forty or more cats on which the operation was performed, this disturbance appeared only in the animals in which the lesion was successfully placed in the corpus striatum. Consequently, it cannot be attributed to injury of the temporalis muscle. It is in a complete destruction of the dorsal part of the putamen and globus pallidus that the defect in feeding movements is most pronounced. The animal seems unable to open its mouth widely enough to take in food, although a great effort is made to do so. In an

attempt to lap food, the tongue is also shown to be stiff and its movements restricted. Food successfully taken into the mouth is handled with great difficulty, and frequently falls from the mouth during attempted chewing movements. Feeding is also accompanied by much slobbering. There is always the appearance that the animal is putting forth the utmost voluntary effort possible during attempts to take food. Chewing is limited, and the movements are awkward and unorganized. There is a lack of the smooth, automatic correlation characteristic of the usual movements of mastication. Swallowing is accomplished only by great effort, somewhat as if the animal were attempting voluntarily to swallow an object stuck in its throat. Frequently, the animal makes more than one effort before successfully swallowing a small bit of food.

From six to ten days after the operation, it was characteristic of these animals for the muscles which were originally spastic to become relaxed to a varying degree, corresponding to the severity of the original symptoms. That is, there was greatest relaxation of the muscles in those animals which showed the greatest rigidity and the most pronounced difficulties in feeding. In cat 471, the difficulties in taking and manipulating food were evident but were not extremely pronounced. When the muscles relaxed after a few days, the jaws did not sag as in some cases, but the muscles showed a distinct lack of tone. There was a weakness and somewhat of a paralysis in connection with feeding movements. The jaws were snapped open and shut without the smooth rhythmic movements normal to mastication, and each movement seemed to be the result of a conscious effort. Swallowing was still accomplished with a great deal of effort. In a more severe case, such as cat 445 or 448, the animal, immediately after the operation, was practically unable to take or manipulate food, so great was the disturbance of the feeding movements. After a few days the muscles relax almost completely; the lower jaw sags down and hangs in a relaxed, helpless manner; the tongue hangs listlessly from the mouth in a paralyzed manner; there is much slobbering, and feeding becomes impossible. The tongue can be lapped only slightly in an unorganized, helpless manner. The jaws cannot be closed with any force.

It seems most probable that the symptoms immediately following the operation are symptoms of irritation, and that the later relaxation represents the true release symptoms following the short period of irritation produced by the lesion.

One of the clinical cases of degeneration in the globus pallidus described by Hunt corresponds closely to the conditions found in these animals. In the early stages of the disease, there was a marked spasticity of the muscles of the jaw and tongue. In later stages, there was a relaxation of these muscles resulting in the mouth remaining open and

the tongue hanging flaccidly from the mouth. The cases reported by Wilson are characterized, however, in later stages, by the mouth remaining widely open, which is accompanied, according to him, by "spasticity" of the muscles.

Cats 444 and 420 were noted to make the usual movements accompanying meowing without emitting any sound. Cats 471 and 434, although showing marked difficulties in mastication, were able to meow in a normal manner. There was no attempt on the part of cat 448 to meow while under observation. Cat 445 possessed a weak, croaky meow, somewhat resembling the bleating of a small lamb. Although the voice symptoms in these cases do not show a single consistent defect, there is some indication that the voice mechanism itself is affected in some way by lesions in the corpus striatum. The type of animal experimented on, however, does not furnish an opportunity for observations on defects in articulation.

The severity of the feeding symptoms corresponds closely to the amount of degeneration described in the lateral striobulbar fasciculus. It seems apparent that, although the cortex exercises some control over the feeding movements, the fundamental mechanism for automatic associated feeding movements lies within the corpus striatum and is particularly concerned with the most dorsal part of that nucleus. The effect of injury in this region may be due partly perhaps to the fact that the fibers leaving the globus pallidus to form the lateral striobulbar fasciculus converge through the dorsal part of the globus pallidus and are injured at their point of exit from the nucleus.

CONCLUSIONS

In the present state of knowledge, it is difficult to determine specifically the function and significance of the corpus striatum in mammals and in man. Little is known of the afferent connections of the corpus striatum on the one hand and on the other hand little of the significance of many nuclei over which the corpus striatum exercises some control, such as the subthalamic nucleus of Luys, nucleus mammillo-infundibularis, substantia reticularis hypothalami, the intrapeduncular nucleus of Malone, the interstitial nucleus, and the nucleus of Darkschewitsch.

The exact origin and significance of the afferent fibers from the region of the thalamus and subthalamus to the corpus striatum are not clearly understood. The medial lemniscus has been shown to terminate, largely at least, within the lateral nucleus of the thalamus; the exact termination of the spinothalamic tracts is not definitely known, while the trigeminothalamic fasciculus is considered by some authorities (Wallenberg, van Gehuchten and Winkler) to terminate in the region of the nucleus reuniens. Many investigators (Marchi, Russell, Thomas,

Wallenberg, van Gehuchten, von Monakow and Luna[40]) find fibers of the brachium conjunctivum passing through the red nucleus to terminate in the thalamus, while Thomas, Wallenberg, Luna and Allen describe fibers of the brachium conjunctivum terminating also in the subthalamic region. There is the possibility that any of these afferent systems of fibers may be relayed into the corpus striatum. This phase of the problem is largely, as yet, a matter of speculation.

It is likely that nuclear masses such as the subthalamic nucleus of Luys have some specific function which is controlled to some degree by the corpus striatum. Although the connection of the corpus striatum with the red nucleus is a minor one, it is probable that the striate system and the cerebellar system are closely associated through their fiber connections with the subthalamic region. I have pointed out that there is some indication that the fibers which arise from the intrapeduncular nucleus, as the striate fibers terminate in that nucleus, form a fasciculus which joins the cerebral peduncle and would either continue downward in the peduncle or separate off with the corticopontile fasciculus, perhaps to reach the cerebellum.

Wilson has made an attempt to account for dysarthria and dysphagia by stating that they are due to spasticity of the muscles resulting from the loss of the steadying influence exerted by the corpus striatum. He does not offer a satisfactory explanation for the fiber connections through which this could be brought about. Hunt and most other authors have refrained from dealing with this phase of the symptomatology of the corpus striatum. The lateral striobulbar fasciculus described in this paper accounts for a direct connection from the corpus striatum to the masticator, facial, ambiguus and hypoglossal nuclei. These anatomic observations support the conclusions arrived at from the clinical and physiologic approach that the corpus striatum is concerned in some way with the mechanism of voice, mastication, deglutition, and facial expression. I have also shown that a portion of this striobulbar fasciculus is dissipated in the region of the reticular nuclei of the pons and oblongata. In a recent paper by Papez,[41] it has been shown that these reticular nuclei emit a great system of reticulospinal tracts. From a review of physiologic evidence,[42] it seems likely that the vasotonic centers exist in this region. An explanation of this strioreticular and reticulospinal system of connection which suggests itself is that it is a tonic system for vascular tissue, and may be in part the

40. In Allen: Distribution of the Fibers Originating from Different Basal Cerebellar Nuclei, J. Comp. Neurol. **36**:399, 1924.

41. Papez, J. W.: Reticulospinal Tracts in the Cat: Marchi Method, J. Comp. Neurol. **41**:365 (Aug.) 1926.

42. Ranson, S. W.: Afferent Paths for Visceral Reflexes, Physiol. Rev. **1**:490, 1921.

anatomic basis for trophic disturbances and disturbances of vascular tonus, as suggested by Papez in his work on the reticulospinal tracts.

In fish, the endbrain is composed largely of an olfactory bulb and olfactory lobe in close relation to which lies the specialized collection of cells, the epistriatum. The floor of the caudal portion of the endbrain consists of the basal ganglia, the forerunner of the globus pallidus in man and mammals. It is apparent in fish that the basal ganglia are closely related to the olfactory centers and form primarily a feeding mechanism. Sheldon [43] has shown that the shark is dependent on the sense of smell for finding its food. When the food is thus located the fish stops for an instant, the muscles become tense and it dives after the food, taking it into the mouth. This activity probably represents in the true sense a function of the basal ganglia. The characteristic habits of various forms of fish in depositing, fertilizing, and sometimes in caring for the eggs, may also be dependent on the corpus striatum.

In birds which have become highly specialized in motor activities, the corpus striatum is also highly specialized. It still has control over the feeding movements such as the movements of the head in pecking, movements of the jaws, movements of the tongue and swallowing, as shown by the work of Kalischer and Rogers. Since the bird depends largely on sight for the location of food, the retina has probably established an afferent connection with the corpus striatum as suggested by Kalischer, either through the medial geniculate body, the superior colliculus, or both. Although the simpler automatic flying movements of birds are probably dependent on a lower center, this center is under the control of the corpus striatum so that the swooping upward and downward and from one side to the other in pursuit of insects or other prey and in avoiding the enemy are movements dependent on the corpus striatum. The song or call of the bird is probably dependent on the corpus striatum, as suggested by the work of Kalischer, as well as the nesting and mating habits as suggested by Rogers.

The lower mammals are dependent on sight, smell, and to some degree skin sensibility—particularly of the face and head—for the location of food, and the escape from enemies. One might expect the corpus striatum to have afferent connections with at least the optic mechanism, olfactory mechanism, and the tracts carrying skin sensibility, especially the sensations from the head and face, and perhaps also a connection with the gustatory centers. The olfactory connection has been shown, the trigeminal connection, based on slender evidence, is assumed by many workers, while the remaining connections are as yet based almost solely on speculation. While there is perhaps some

43. Sheldon, R. W.: The Sense of Smell in Selachians, J. Exper. Zool. **10**:51, 1911.

lower center (probably in the subthalamus) for the more simple reflex walking movements, this center is probably under the control of the corpus striatum. Springing on prey, dodging, turning, and all the more primitive movements of pursuit, flight, defense and attack are probably controlled by the corpus striatum. Seizing and handling food, as well as perhaps the mating activities, are dependent on the striatum. There is close cooperation between the corpus striatum and cerebellum in bringing about these fundamental associated movements.

In man, the functions of the corpus striatum are so masked by the activities of the cortex that they are hard to analyze. It probably has to do with the more primitive, fundamental, automatic associated movements as suggested by C. and O. Vogt, Ramsay Hunt, Jakob, Lhermitte, Lewy, Foerster, and others. The nursing movements of the infant and the action of the young child in seizing objects, carrying them to the mouth and attempting to eat them, probably represent activity of the corpus striatum. In the adult, the movements of the jaw and tongue and the movements of swallowing incident to eating may be initiated or inhibited by the cortex, but the smooth, automatic associated performance essential to these activities is probably dependent on the corpus striatum. This is true, perhaps to a much less degree, with the movements of the tongue, lips, jaws, etc., in speaking, since articulation and phonation are to a large degree acquired by practice. The automatic rhythmic association of walking movements is perhaps due to the corpus striatum.

Through Meynert's commissure, there is a close association between the corpora striata of the two sides. In addition, the efferent fiber system of each corpus striatum is distributed to the contralateral as well as to the homolateral side. Ramón y Cajal has described collaterals from the cortical fibers continuing into the subthalamic nucleus of Luys and the nucleus which he describes as the nucleus of the internal capsule. He considers that the fasciculus lenticularis of Forel is composed of cortical rather than striate fibers. This suggests that many of the motor nuclei which receive fibers from the corpus striatum may also receive fibers from the cerebral cortex. If this is true, it explains the dual control of the corpus striatum and cortex over many of the motor functions. I have pointed out the possibility that the striate fasciculus which terminates on nuclei in the lateral region of the substantia nigra may be relayed through these nuclei to the cerebellum. Also, there is a possibility of a correlation between the corpus striatum and the cerebellum in the subthalamic region in which both striate fibers and fibers of the brachium conjunctivum terminate. It is therefore probable that there is not only a close association between the corpora striata of the two sides but also a close association in the function of the corpus striatum, cerebral cortex and cerebellum.

I am convinced that the symptomatology usually ascribed to the corpus striatum is due to an irritation rather than to a deficiency of cells.

There is every indication that the hypertonicity of the skeletal muscles is an irritation phenomenon which lasts for a brief time following the injury to the corpus striatum. Rogers was able to produce contraction of the muscles of the neck and shoulders and extension of the forelegs of the opossum by electric stimulation of the corpus striatum. In nearly all clinical cases described, a lesion has occurred in the corpus striatum of both sides, followed by bilateral spasticity and hypertonia. One might well conceive of the hypertonic condition of the muscles found by Rogers following the electric stimulation and during circus movements that I have already described, as corresponding to the spasticity and hypertonia of progressive lenticular degeneration in man, if the experimental lesion in animals was bilateral instead of affecting the corpus striatum of only one side. It has been repeatedly emphasized that most of the pathologic conditions of the corpus striatum in man are of a progressive nature. The symptoms have been found to alter considerably from time to time in many cases, some agent, presumably of a toxic nature, acting on the cells of the corpus striatum and causing them slowly to degenerate over a period of several months. It seems reasonable to expect that a toxin or other factor which would thus cause slow degeneration of the cells would at the same time act as a constant stimulus to those cells which remained capable of stimulation. In a gross mechanical lesion, however, such as has been made in the animals described in this paper, there is sudden destruction of a certain area of cells, followed by invasion of the cavity with blood. This blood at first exerts pressure, then clots and is slowly absorbed. There is always a narrow layer of degeneration surrounding the lesion. The myelin sheath and nerve fibers undergo a process of peripheral degeneration, which lasts for a few days. It is believed by many workers that this degenerative process acts on the cells on which these fibers terminate much as a nerve impulse would act. In other words, a current of degeneration is set up within an injured nerve fiber which may account for the symptoms present during the few days following the lesion. The injury itself, and the consequent readjustment of the tissues surrounding the lesion, would cause additional irritation.

In case 1 of this paper, there was a large, smooth-walled cavity in the lenticular nucleus of each side. There was sufficient destruction of the corpora striata to account for the most severe symptoms which accompany progressive lenticular degeneration if these are conceived of as release symptoms. However, it will be noted that, although

the case record is brief, there are no indications of a syndrome of the corpus striatum.

Further support is perhaps given to the view that the symptoms commonly attributed to the corpus striatum are irritative rather than release symptoms, by one of the animals in which the parietal cortex was extirpated. For several hours, this animal showed no symptoms except to have hallucinatory fits and to exhibit athetosis and hypersensibility to skin stimuli. After about two days, the animal began to develop symptoms typical of injury to the corpus striatum. There was tremor in the tail and body and hypertonus of the muscles, particularly on the right side, circus movements toward the injured side, spasticity of the jaws and difficulty in swallowing. These symptoms increased in severity until the animal was killed ten days after the operation. Microscopic examination showed, in addition to the original injury to the cortex, a degenerated area of considerable size in the most caudal part of the globus pallidus, including both lateral and medial divisions. This degeneration was on the same side as the lesion and apparently had begun incident to the lesion and had continued progressively until the animal was killed. This seems to show that a small degeneration in the globus pallidus produces the same symptoms as a large mechanical lesion involving a much wider area. The mechanical lesion, although it destroys practically all the globus pallidus on one side, is followed by complete recovery within a few days, while with the degenerative lesion the symptoms continue to progress in relation to the severity of the degeneration. In one of the most serious cases of progressive atrophy in the globus pallidus described by Hunt, he estimates that there is loss of perhaps one sixth to one fourth of the motor cells of the globus pallidus and putamen. It seems doubtful whether the loss of that proportion of the cells is sufficient to account for the symptoms. On the other hand, if one conceives of these symptoms as due to irritation by the toxin or other agent responsible for the degeneration process the symptoms could be considered as due not only to the degenerative process in those cells that are being destroyed but also to an irritative stimulation of the remaining cells.

It is the opinion of most investigators that man is less dependent on the function of the corpus striatum than are lower mammals, yet I have found that the cat is able to compensate within a few days for an almost total loss of the globus pallidus and putamen of one side, with the exception perhaps of the feeding defects. Again, if one conceives the syndrome of Wilson's lenticular degeneration as due to the irritative stimulation accompanying the degenerative processes, these symptoms can be more easily explained. Progressive lenticular degeneration affects first the putamen and may spread to the globus pallidus in the more advanced stages of the disease. It is important to note that

in these cases the globus pallidus, which is the motor division of the corpus striatum, remains intact throughout almost the entire course of the disease. Therefore, one might expect more severe symptoms than are obtained in a disease which slowly destroys these cells as the degenerative process continues, which has been shown to be the case. That is, the irritative stimulation of the toxin or other agent which is destroying the cells of the putamen stimulates an ever increasing area in that nucleus. These stimuli are being constantly discharged into the globus pallidus, which in turn is responsible for the symptoms. When the putamen is completely degenerated and the process of degeneration spreads into the globus pallidus, the irritative stimulation still continues on the cells of that nucleus.

If this view is correct there is more hope of dealing successfully with disease of this nature, for if the cause of progressive degeneration in the corpus striatum can be located and eliminated at almost any period during the progress of the disease, one may expect the patient to be able to compensate sufficiently to recover almost completely.

SUMMARY

Following a study of degenerations in the cat by the Marchi method and a study of secondary degenerations in human brains, efferent fiber systems from the globus pallidus have been shown to terminate in: (1) the mammillo-infundibular nucleus of Malone; (2) substantia reticularis hypothalami of Malone (cephalic part), (nucleus of Forel's field) of the same and opposite sides; (3) the subthalamic nucleus of Luys; (4) the subthalamus ventrocaudal to the thalamus (caudal part of the substantia reticularis hypothalami); (5) interstitial nucleus of Cajal and nucleus of Darkschewitsch; (6) oculomotor nucleus and nucleus of Westphal-Edinger; (7) red nucleus (?); (8) motor division of the substantia nigra (intrapeduncular nucleus of Malone); (9) peripeduncular nucleus of Jacobsohn.

Through a striobulbar fasciculus, fibers terminate in: (10) the trochlear and abducens nuclei; (11) reticular nuclei of the pons and medulla (not definitely proved); (12) masticator nuclei; (13) facial nuclei; (14) ambiguus nuclei; (15) hypoglossal nuclei; (16) through Meynert's commissure to the globus pallidus and region of Forel's field H_2 of the opposite side.

In general, the fibers taking origin in the ventral part of the globus pallidus, especially in the medial division, terminate on nuclei in the subthalamic region and the region of the posterior commissure, and have to do with general movements of the body. Fibers arising in the dorsal part of the globus pallidus, especially in the lateral division, are distributed to motor nuclei of the pons and medulla and are concerned with speech, mastication, deglutition and facial expression.

A lesion in the left lenticular nucleus of the cat involving the ventral part of the lateral division and injuring the medial division of the globus pallidus is followed by: (1) left circus movements accompanied by extreme hypertonicity of the muscles on the left side of the body; (2) a general hypertonic, restless condition affecting all muscles of the body; (3) constriction of the left pupil; (4) athetosis in some cases, and occasionally tremor. These symptoms all disappear within eight or ten days, except the constriction of the left pupil, and the muscles that were previously hypertonic become somewhat hypotonic.

A lesion in the dorsal part of the putamen and lateral division of the globus pallidus is followed by disturbances of the voice and difficulties in taking, masticating and swallowing food. These symptoms are at first due apparently to spasticity of the muscles concerned in these activities. After eight or ten days, these muscles relax and lose their tonus until a partial paralysis results.

The early symptoms that follow lesions in the lenticular nucleus are considered to be caused by irritative stimulation due partly to the degenerative process in the striate system of fibers stimulating lower motor centers in the subthalamus, midbrain, pons and medulla and partly to irritation of the area surrounding the lesion. The later relaxation and loss of former symptoms is considered a true deficiency phenomenon. It is also believed that the motor disturbances attributed to progressive degeneration in the corpus striatum in man are due to irritative stimulation of the corpus striatum rather than to loss of striate function.

INTRA-OCULAR AND INTRACRANIAL PRESSURE

AN EXPERIMENTAL STUDY *

FRANK FREMONT-SMITH, M.D.
AND
HENRY S. FORBES, M.D.
BOSTON

The results of simultaneous investigation of analogous biologic processes may have significance reaching beyond an understanding of individual organs, for such study touches directly on the unity of the organism. The many analogies between the eyeball and the cranium have been emphasized by Thomson Henderson [1] in 1910 and by Wegefarth and Weed [2] in 1914, but Mestrezat,[3] in 1912, established the fundamental identity of aqueous humor and cerebrospinal fluid.

These relationships have been discussed recently by one of us (F. F.-S.[4]) in a critical review on the nature of the cerebrospinal fluid. The evidence indicates that this fluid, and also the aqueous humor, both of which are nearly protein-free, are dialysates in equilibrium with the blood plasma. This concept, first formulated by Mestrezat,[3] follows in the main the ideas on fluid exchange between capillaries and tissue spaces set forth by Starling [5] in 1909; it assumes a simple membrane equilibrium to exist between the plasma, on the one hand, and the cerebrospinal fluid or aqueous humor, on the other. In order that the significance of the data to be presented may be understood, a restatement of the principles involved in this type of equilibrium is essential.

In such a system, the rate of filtration or dialysis will be dependent on a balance between the hydrostatic capillary pressure and the osmotic pressure exerted by the plasma proteins, since the proteins are the chief substances in the plasma to which the capillary wall is impermeable. When the composition of the plasma remains constant, the amount by which the capillary blood pressure exceeds the osmotic pressure of the plasma proteins [6] becomes the effective filtration pressure. Thus,

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* From the Department of Neuropathology, Harvard Medical School.

1. Henderson, Thomson: Glaucoma, London, Edward Arnold, 1910.

2. Wegefarth, P., and Weed, L. H.: J. M. Research **31**:167, 1914.

3. Mestrezat, W.: Le liquide céphalo-rachidien, Paris, A. Maloine et fils, 1912.

4. Fremont-Smith, F.: The Nature of the Cerebrospinal Fluid, Arch Neurol. & Psychiat. **17**:317 (March) 1927.

5. Startling, E. H.: The Fluids of the Body, Chicago, W. T. Keener & Co., 1909.

6. The possible significance of substances other than protein, to which the capillary wall may be impermeable, must not be overlooked. For the sake of simplicity only the plasma proteins are considered in this discussion.

under these conditions, the rate of filtration will vary directly with the capillary pressure. When, however, this capillary pressure becomes less than the osmotic pressure of the plasma proteins, no filtration can take place, the direction of flow across the membrane will be reversed, and absorption will occur. In most parts of the body the capillary bed may be considered to be such a dialyzing membrane through which both filtration and reabsorption are constantly taking place. At the arterial end of the capillary bed, where the blood pressure is higher, there will be filtration into the tissue spaces, while at the venous low pressure [7] end of the system absorption will occur. The similarity of this mechanism in the cranium and in the eye is great: [4] filtration from the capillary bed of the choroid plexus (or ciliary process) and reabsorption into the venous dural (or scleral) sinuses.

Whenever absorption does not keep pace with filtration, there will be an accumulation of fluid in the tissue spaces, recognized in the elastic skin and subcutaneous tissues by edema. In the cranium and the eye, however, which are rigidly enclosed, this results in an increase in pressure—hydrocephalus or glaucoma. A more detailed discussion of the mechanism of hydrocephalus will be found in an earlier communication.[4]

The delicately balanced interrelationship between the formation and absorption of fluid, which maintains a normal and relatively constant intracranial and intra-ocular pressure, may be explained without invoking a secretory mechanism when one bears in mind the fact, pointed out many years ago by Ludwig and insisted on by Leonard Hill,[8] that *capillary pressure is far more dependent on venous pressure than on arterial pressure,* because of the high resistance to blood flow in the arterioles which are interposed between the arterial pressure and the capillary bed. In this connection, Carrier and Rehberg,[9] working in Krogh's laboratory, have clearly demonstrated, by direct measurement, that the capillary pressure in the hand bears a constant relationship to the venous pressure in the hand, both varying directly with the height of the part relative to the thorax.

The rate of absorption of fluid in the eye or in the cranium accordingly must vary directly with the venous pressure of scleral or dural sinuses, while the rate of formation will vary with the capillary pressure in the ciliary process or the choroid plexus. But we have just shown

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7. Landis has demonstrated by direct measurement such a capillary pressure gradient in the mesentery of the frog (Landis, E. M.: Am. J. Physiol. **75**:548, 1926).

8. Hill, Leonard: The Cerebral Circulation, London, J. & A. Churchill, 1896.

9. Carrier, E. B., and Rehberg, P. B.: Skandin. Arch. f. Physiol. **44**:20, 1923. Krogh, A.: The Anatomy and Physiology of Capillaries, New Haven, Yale University Press, 1922, Lecture X, p. 217.

that the capillary pressure is primarily controlled by the venous pressure. Hence, provided the osmotic pressure of the plasma remains unchanged, *the rate both of formation and of absorption must depend on the venous pressure and vary directly with the venous pressure.*

This explains why both aqueous humor and cerebrospinal fluid pressures are so intimately related to the venous pressure and are much less affected by changes in arterial pressure.[10]

These considerations are of prime importance for an understanding of the physiology and pathology of intracranial and intra-ocular pressure. They are equally important in the control of fluid exchange throughout the body. There are other factors that may complicate to a greater or lesser degree the simple mechanism outlined. Among those that need further investigation are: the difference in composition of arterial and of venous plasma, the effect of tissue metabolism on the composition of the tissue fluids, the relative areas of diffusing surface for the formation and absorption of fluid and the permeabilities[11] of the membranes themselves.

EXPERIMENTAL METHOD

In order to emphasize the analogies between the cerebrospinal fluid and the aqueous humor and their relationship to the problem of fluid exchange in the organism, we have combined, simultaneously in the same animal, certain of Weed's[12] experiments on intracranial pressure with those of Duke-Elder[13] on intra-ocular pressure. Simultaneous pressure readings of aqueous humor and cerebrospinal fluid have been taken at minute or one-half minute intervals in twenty-three animals: nineteen cats, three dogs and one rabbit. Iso-amyl-ethyl barbituric acid,[14] 1 per cent, injected intraperitoneally, was the anesthetic used in all except five cases. Barbital was used twice, morphine and ether twice, and ether once. The duration of the continuous observations was from twenty minutes to over six hours. All observations were made with the animal lying horizontally on its right side. Cerebrospinal fluid pressure was recorded by inserting an 18 gage needle through the occipito-atlantoid ligament into the cisterna magna. The needle was first attached by a rubber tube to a 1 mm. bore water manometer filled with Ringer's solution to about the 100 mm. mark. The intra-ocular pressure was obtained by inserting a sharp needle through the cornea into the anterior chamber, the needle being attached to a similar manometer filled with Ringer's solution to about the 140 mm. mark. In

10. Henderson, T.: (footnote 1). Hill, L.: (footnote 8). Becht, F. C., and Matill, P. M.: Am. J. Physiol. **51**:126 (Feb.) 1920. Becht, F. C., and Gunnar, H.: Am. J. Physiol. **56**:231 (June) 1921.

11. For an excellent discussion of capillary permeability as related to fluid exchange, see Landis, E. M.: Am. J. M. Sc. **172**:463, 1926.

12. Weed, Lewis H.: Physiol. Rev. **2**:171 (April) 1922. (Contains full bibliography.)

13. Duke-Elder, W. S.: Brit. J. Ophth. **10**:1 and 30, 1926.

14. We wish to acknowledge the kindness of Eli Lilly & Co., Indianapolis, who furnished us with this material for experimental purposes.

inserting the eye-needle, a point was chosen in the cornea near the limbus. The eye was steadied by a small hemostat attached to the conjunctiva near the point of insertion. It was found important not to touch the iris with the needle, and the best results were obtained when a sharp needle was inserted with a single thrust. Various sizes of needles were used in the eye. In one experiment two needles—one a fine hypodermic, the other an 18 gage—were inserted into the same eye and attached to separate manometers. The pressures were identical in these two manometers, proving that variations in size of needle do not cause significant error. In the majority of cases there was a progressive rise in eye pressure for some minutes after the needle was inserted. This we believe is due to the trauma involved, but its exact mechanism is not clear. To avoid this reaction, the finest needle and least manipulation of the eye is best. On the other hand, the aqueous humor tends to increase in protein content, particularly in prolonged observations. A slight amount of clot will obstruct the smallest needles. When observations are to be prolonged, a larger needle is preferable.

We have not prevented the movement of fluid in or out of the eye or the cranium. Had we done this, the changes in pressure would have been more marked, that is, if outflow is prevented, a rising pressure will reach higher levels, while if inflow is prevented, a falling pressure will reach lower levels than would be obtained by our method. Accordingly, the actual values obtained for intra-ocular pressure have not a quantitative significance and cannot be compared directly to the cerebrospinal fluid pressure. That the direction of change of pressure indicated is correct, and that the actual values are usually not greatly in error is demonstrated by taking the pressure in the hitherto untouched eye. This has been done after the intra-ocular pressure, as measured in the first eye, has been experimentally changed by altering the osmotic pressure of the blood. It has then been found that the pressure in the second eye has reached essentially the same new level as that now recorded in the first eye (figs. 6 and 7).

Venous pressures were not recorded, since their relationship to intracranial pressure has been demonstrated by Leonard Hill [6] and by Weed,[12] and to intra-ocular pressure by Wegefarth [15] and by Duke-Elder.[13]

As it has been our purpose to correlate observations which are already well established individually for the eye or the cranium, rather than to establish a new set of observations, we have not published detailed accounts of all our protocols, but have included one or two typical records of each of the more significant, simultaneous observations on intracranial and intra-ocular pressures.

We have found in the literature only two papers dealing with such simultaneous measurements. Thomson Henderson [1] stated, in 1910, that he and Leonard Hill recorded intra-ocular and intracranial pressures simultaneously in seven experiments, and that "under all experimental conditions" the pressures were identical and varied directly with the systemic venous pressure.

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15. Wegefarth, P.: J. M. Research **31**:149, 1914. Weed, L. H., and Hughson, W.: Am. J. Physiol. **58**:53, 1921.

Two years later, Hill [16] devised a new type of needle, and came to the conclusion that the intra-ocular pressure was much higher than the intracranial (approximately six times as high). Observing no respiratory oscillations in the eye manometer, he concluded, furthermore, that the intra-ocular pressure was so high that the variations in the venous pressure did not influence it. Throughout our experiments, in which no air bubble was used in the manometer, respiratory oscillations were always present, unless the needle or the tube became obstructed. The extent of the oscillations depended on the bore of the needle and of the manometer, and varied constantly with the character and the depth of the respirations. Possibly the absence of visible oscillations in Hill's experiments was due to the type of manometer used, and especially to the presence of an air bubble used by him as an index. Evidently, the intra-ocular pressure is not too high to be influenced constantly by changes in venous pressure. That is one point on which our observations bring direct evidence.

Block and Oppenheimer [17] observed intra-ocular pressure by tonometer and intracranial pressure by lumbar puncture simultaneously in 100 patients. They conclude that although individual parallelism does not exist between intraspinal pressure, arterial pressure and ocular tension, there is a general tendency for high or low pressures in any one of these to be associated with similar pressures in the other two.

We have, in certain instances, made more than one observation during a single experiment; thus, the effect of chest compression, of intraperitoneal injection of a concentrated solution of urea, of jugular compression and of inhalation of carbon dioxide were studied in succession in one animal. We have felt that this was permissible when the character of the response was well established and the significance of the experiment lay in the parallel changes in intracranial and intra-ocular pressures.

EXPERIMENTAL RESULTS

In general, we have found a striking parallelism between the changes in pressure in the eye and in the cranium when these changes are induced by general vascular hydrostatic or osmotic agencies. Local changes in pressure in the cranium or in the eye, however, are not accompanied by parallel changes in the other, thus proving that there is no significant transmission of pressure directly from the eye to the cranium or vice versa. Figure 1 (*A*) shows the immediate response to chest compression (twice) and figure 1 (*B*) the similar response to

16. Hill, Leonard, and Flack, M.: Proc. Roy. Soc. London B **85**:439, 1912.

17. Block, E. B., and Oppenheimer, R. H.: A Comparative Study of Intraspinal Pressure, Blood Pressure and Intra-Ocular Tension, Arch. Neurol. & Psychiat. **11**:444 (April) 1924.

jugular compression, while figure 1 (*C*) (same animal a few minutes later) shows a local rise in the ocular pressure due to the trauma of manipulating the eye-needle, without any corresponding change in cerebrospinal fluid pressure. That this was a local change in pressure is proved by inserting a needle into the other eye a few minutes later (fig. 1 *D*). This showed a much lower pressure. It is partly because of the ease with which this rise in local intra-ocular pressure may be produced, and partly because of our lack of full understanding of its

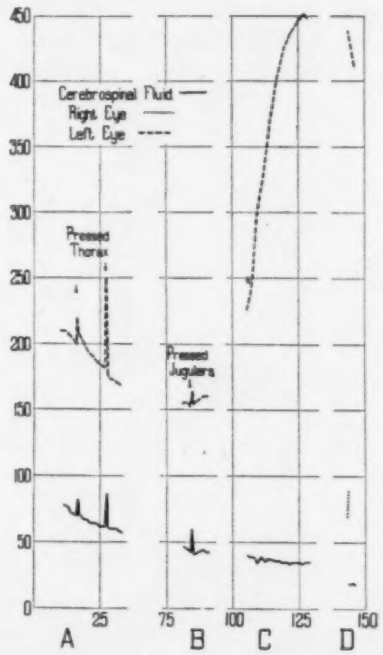

Fig. 1 (Dec. 17, 1925).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Pulse and respiratory oscillations were visible in manometers connected with the eye and the cistern. Immediate rise occurred in intra-ocular and intracranial pressures with pressure by the hand on the chest (*A*) or on the jugulars (*B*). The conjunctiva (left) finally became reddened and the intra-ocular pressure rose steadily (local trauma) (*C*), but with no accompaning rise in cerebrospinal fluid pressure; a needle now inserted into the right eye showed its pressure also low (*D*).

mechanism, that we have been unable to reach conclusions as to the normal relative pressures in the cranium and in the eye. Our records show the intra-ocular pressure maintained at a level above that of the intracranial pressure throughout a majority of the experiments; yet we

have no assurance that this represents the normal relationship. In certain cases, moreover, the two pressures have been almost identical at the beginning of the experiment.

In general, the changes in intra-ocular pressure have been somewhat slower and of less degree than the changes in intracranial pressure. At times, the two pressures have moved in opposite directions. Often this could be explained by assuming a latent period before intra-ocular pressure responded, but at other times we were unable to explain this phenomenon.

The respiratory and pulse excursion, which is regularly to be seen in a manometer attached to the subarachnoid space, is always paralleled

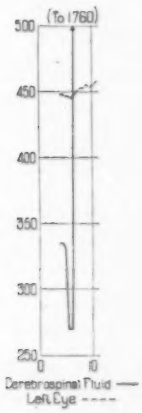

Fig. 2

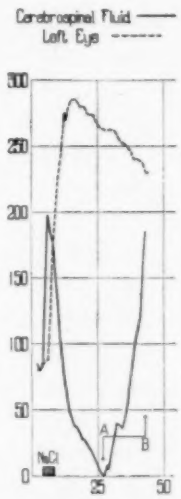

Fig. 3

Fig. 2 (April 23, 1926).—Curves showing the intracranial pressure and eye pressure in a dog under morphine and ether anesthesia, the tracheal tube being used. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Respiratory and pulse oscillations were visible in the eye manometer. The intracranial pressure was artificially raised to an extreme height by raising a container filled with Ringer's solution connected by rubber tubing with the cistern needle. No noticeable immediate rise occurred in the eye pressure.

Fig. 3 (Nov. 18, 1926).—Curves showing intracranial pressure and eye pressure in a cat under sodium barbital anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Respiratory and pulse oscillations were visible in the eye and cistern manometers. Ten cubic centimeters of sodium chloride (30 per cent solution) was injected into the vein of the leg. When the intracranial pressure had fallen to zero, an isotanic solution was run into the cistern *A-B*, thus mechanically raising the intracranial pressure. The eye pressure did not follow this rise but continued to fall in response to the hypertonic solution in the blood stream.

in the aqueous humor pressure, provided there is no obstruction in manometer or needle. The amplitude of oscillation is usually less in the eye, but the relative proportion of respiratory to pulse excursion (normally about 5:1) is maintained. When the animal gives an unusually deep inspiration, a conspicuous drop in both pressures is to be seen.

We have divided our experiments into five general groups: 1. The first group contains those in which the pressure was varied locally in either the eye or the cranium to show that such a local change in pressure was not directly transmitted from one to the other. One example of this already has been given (fig. 1 *D*). Direct pressure on the eyeball raising intra-ocular pressure to a high point has

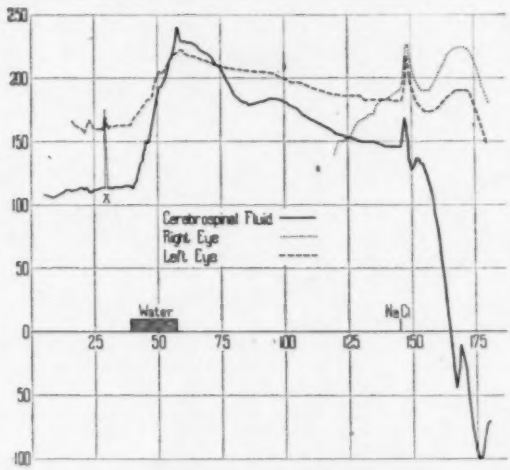

Fig. 4 (May 11, 1926).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Respiratory and pulse oscillations were visible in the eye and cistern manometers. Pressing with one hand on the cat's chest (at "X") caused a sharp rise in both eye and intracranial pressures, and these both fell again at once to their base lines, the eye somewhat more slowly. Ninety cubic centimeters of distilled water was injected into the vein of the leg. There was a prolonged rise in intra-ocular and intracranial pressures. Thirty cubic centimeters of sodium chloride (30 per cent solution) was injected into the peritoneal cavity. Immediate rise in both pressures was followed by a fall, more slowly in the eye, but showing in general a parallelism. The second eye curve was parallel to the first and approximated the same level.

little or no effect on intracranial pressure. Incising and opening the anterior chamber widely, thus lowering the intra-ocular pressure to zero, does not change the intracranial pressure. Moreover, raising the cerebrospinal fluid pressure rapidly by artificial means to an extreme

height does not cause significant increase in intra-ocular pressure. Figure 2 shows the latter condition. Figure 3 shows a continued fall in the eye pressure, even when the intracranial pressure was being raised by addition of fluid to the subarachnoid space. This mutual independence of intra-ocular and intracranial pressures is seen clinically in the normal intra-ocular pressure found in tumor of the brain and the normal intracranial pressure in glaucoma.

2. In the second group of experiments we studied the response of intra-ocular and intracranial pressures to changes in hydrostatic venous pressure, in the head, as brought about by jugular compression (fig. 1 *B*), throughout the venous system, as by chest compression (fig. 1 *A*), or by the immediate increase in the volume of the blood due to intravenous injection of various solutions. Intraperitoneal injections

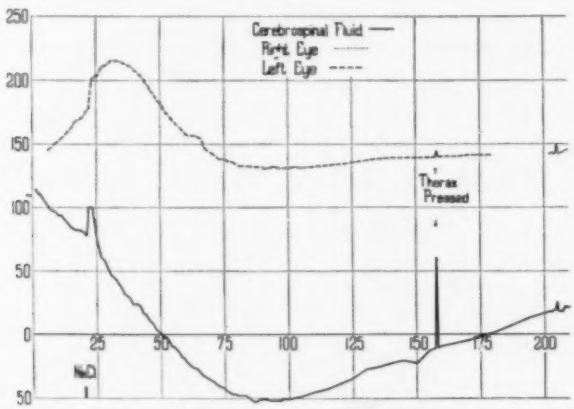

Fig. 5 (April 2, 1926).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Twenty cubic centimeters of sodium chloride (30 per cent solution) was injected into the peritoneal cavity. An immediate rise was followed by a fall in both pressures, more slowly in the eye. Compression of the thorax caused a rise in both pressures with prompt return to base line. The other eye was punctured and showed the same pressure level as that reached by the first eye.

of these solutions, as well as intestinal injection of tap water, also cause a prompt and parallel rise in intra-ocular and intracranial pressures (figs. 3 to 8 inclusive). In these experiments it will be seen that the immediate effect of each injection was a prompt rise in both pressures. The continued effect of these injections varied with the osmotic pressure of the solution used.

3. The continued osmotic effects make up the third group of experiments, in which parallel changes were induced in intracranial and intra-ocular pressures. When a hypertonic (30 per cent) solution of

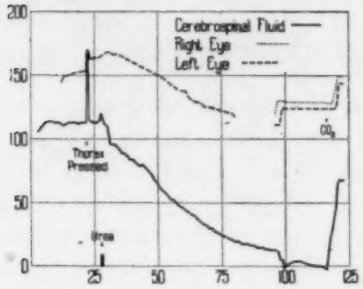

Fig. 6 (May 18, 1926).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observation of pressures were made at one minute intervals. Respiratory and pulse oscillations were visible in the eye and cistern manometers. Compression of the thorax caused an immediate rise in both the eye and the cistern pressures. Thirty cubic centimeters of urea (50 per cent solution in water) administered intraperitoneally was followed by a slight rise and then a gradual fall in both pressures. The second eye, now punctured, showed the same low level as that reached by the first. Finally, inhalation of carbon dioxide was followed by a sharp rise in intracranial and in intra-ocular pressures.

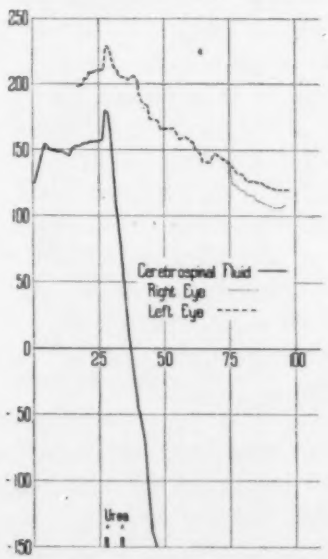

Fig. 7 (May 25, 1926).—Curves showing intracranial pressure and eye pressure in a cat under ether anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Twenty-five cubic centimeters of urea (50 per cent solution in water) was given intraperitoneally. Same dose was repeated three minutes later. Both intracranial and intra-ocular pressures rose sharply and then fell, the eye pressure more slowly. The intracranial pressure fell rapidly until the low point could no longer be recorded by the manometer in use. More fluid was then added to the cistern manometer, raising the pressure till it could be again recorded. The pressure immediately began to fall again and continued to fall until the end of the experiment. The second eye, now punctured, showed the same low point reached by the first and the pressure in both continued to fall at the same rate.

sodium chloride was injected intraperitoneally (six experiments) or intravenously (one experiment), when a hypertonic (50 per cent) solution of urea was injected intraperitoneally (three experiments), or when a hypertonic (50 per cent) solution of glucose was injected intravenously (one experiment), the osmotic pressure of the blood was raised, and a fall in both the intracranial and the intra-ocular pressures resulted. Figures 3 to 7 illustrate these effects. It will be noted that the fall in intra-ocular pressure was usually not so prompt and never so marked as the fall in intracranial pressure. The explanation for these differences is not clear. An intra-ocular pressure below atmospheric pressure we have not yet succeeded in obtaining (possibly because inflow of fluid was allowed), although "negative" cerebrospinal fluid pressures were readily produced after hypertonic sodium chloride or urea. Hertel,[18] 1914, used a hypertonic solution of urea injected intravenously to lower intra-ocular pressure in animals. We do not know of data on its effect on intracranial pressure. The prompt and dramatic lowering of the cerebrospinal fluid pressure by means of a hypertonic solution of urea (figs. 6 and 7), its lack of toxicity and its ready elimination by normal kidneys suggest the possibility of clinical application.

4. The fourth group of experiments are the reverse of those just cited. The osmotic pressure of the blood was lowered by intravenous injection (five experiments) or by intra-intestinal injection (two experiments) of a hypotonic solution (distilled water or tap water), and a parallel rise in both ocular and cerebrospinal fluid pressures was noted. These rises of pressure were not particularly well maintained unless large quantities of water were injected, but they form a striking contrast to the effect of hypertonic injections. Figures 4 and 8 show these effects; the experiment illustrated by the latter figure (fig. 8) is practically a repetition of Rowntree's [19] experiments on water intoxication. The explanation of the marked rise of the intra-ocular, as compared with the intracranial, pressure in this case is not clear.

In connection with this group we may mention an experiment in which we have followed the two pressures during an induced hypoglycemia caused by massive doses of insulin (fig. 9). It will be seen that, even in extreme hypoglycemia and during slight convulsive movements, both pressures in this cat (under iso-amyl-ethyl barbituric acid anesthesia) remained within physiologic limits. If the action of insulin is to cause the withdrawal of glucose from the circulation, and if no compensatory mechanism takes place, one would expect the plasma to become somewhat hypotonic, with a resultant rise in both intracranial and intra-ocular pressures. Insulin, then, by rapidly lowering the blood sugar, might raise intra-ocular and intracranial pressures; just

18. Hertel, E.: Arch. Ophth. **88**:197, 1914.
19. Rowntree, L. G.: Physiol. Rev. **2**:116, 1922.

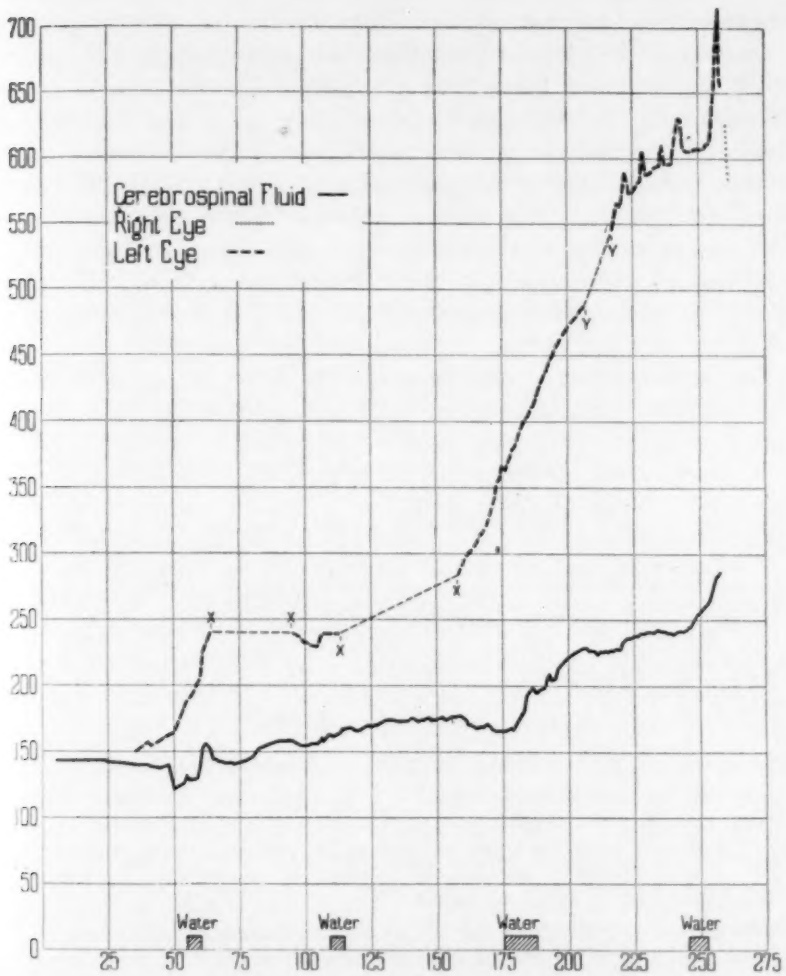

Fig. 8 (June 29, 1926).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Between points *X* the pressure was between 240 and 280, the meniscus being hidden behind a metal ring on the manometer. Between points *Y-Y* the pressure was between 490 and 530, obscured for the same reason. Respiratory and pulse oscillations were visible in the eye and cistern manometers. The peritoneal cavity was opened and tap water was injected into the large intestine. Over 500 cc. of water was injected during the four periods indicated on the chart. Both intracranial and intra-ocular pressures rose—the latter faster and to a much higher point. The second eye, now punctured, showed the same high pressure attained by the first.

opposite to the effect of intravenous injections of concentrated glucose or to the rapid rise in blood sugar in diabetic coma, with its resulting soft eyeballs. Such a conception would be consistent with the observation by Verhoeff and Waite [20] of the sudden onset of acute congestive glaucoma in a diabetic patient whose blood sugar had been rapidly lowered. Figure 9 does not show any significant rise in either pressure, although a slight upward tendency paralleling the falling blood sugar can be made out.[21] This chart is included because we know of no other observations on intracranial or intra-ocular pressure during insulin hypoglycemia, and because of the theoretical interest of the possible effect of insulin on the osmotic pressure of the blood and on fluid exchange.

5. The fifth group of experiments includes the effects of breathing carbon dioxide (one experiment) and carbon monoxide (one experi-

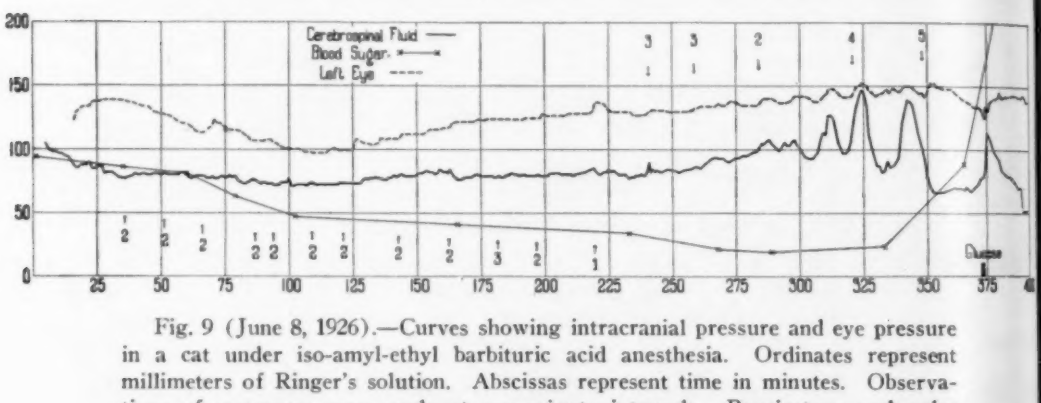

Fig. 9 (June 8, 1926).—Curves showing intracranial pressure and eye pressure in a cat under iso-amyl-ethyl barbituric acid anesthesia. Ordinates represent millimeters of Ringer's solution. Abscissas represent time in minutes. Observations of pressures were made at one minute intervals. Respiratory and pulse oscillations were visible in the eye and in cistern manometers.

At points marked *1*, 0.9 cc. of insulin (18 units) was injected intramuscularly; at points marked *2*, 1 cc. of insulin (20 units) subcutaneously or intramuscularly; at points marked *3*, 1 cc. of insulin intramuscularly and 1 cc. subcutaneously (40 units); at points marked *4*, 2 cc. of insulin (80 units) subcutaneously, and at points marked *5*, 3 cc. of insulin (120 units) intravenously.

As the blood sugar fell there was a gradual upward tendency of the intracranial pressure. Though not marked, it showed a decided contrast to the usual downward course seen in control animals using the same anesthesia. Finally the blood sugar rose spontaneously and at the same time a decided fall in intracranial pressure occurred. Ten cubic centimeters of glucose (50 per cent solution) was now injected intravenously and after an immediate rise during the injection the intracranial pressure again fell sharply.

The method of blood sugar determinations was that of Folin and Wu (J. Biol. Chem. **41**:367, 1920), the final dilutions being made in the modified sugar tubes suggested by Rothberg and Evans (J. Biol. Chem. **58**:435 and 443, 1923). The blood was precipitated immediately on withdrawal.

20. Verhoeff, F. H., and Waite, J. H.: Arch. Ophth. **55**:38, 1926.

21. Miss M. E. Dailey made the tests for blood sugar determinations.

ment) and of the intravenous injection of epinephrine hydrochloride (two experiments) and of fluorescein (one experiment) on the pressure in the eye and in the cranium. With the exception of fluorescein (5 cc. of a 2 per cent solution), which produced no significant change, these agents caused parallel rises in both pressures. The mechanisms of their effects are not clearly understood. It seemed worth while to mention this miscellaneous group of observations because of the parallel changes in pressure induced in the cranium and in the eye.

COMMENT

As suggested in the introduction and as indicated by the experiments, intra-ocular pressure and intracranial pressure may be said to be the result of a delicate balance between the hydrostatic and the osmotic pressure of the capillary and venous plasmas within the eye and the cranium. As long as the composition of the blood remains unchanged, we may expect the intracranial and the intra-ocular pressure to vary directly with variations in general venous pressure.[10] This is also well shown in our experiments of group 2. When, however, the osmotic pressure of the plasma changes, we may find prompt and striking response in intracranial and in intra-ocular pressure, independent of changes in venous or in capillary pressure [22] (experiments of group 3). Thus, if the plasma proteins are concentrated, the osmotic pressure exerted by them may become so great that the capillary pressure can filter little or no fluid through the choroid plexus or ciliary process. Absorption at the same time will be facilitated, with the result that both intracranial and intra-ocular pressures will be lowered. A case of intra-ocular hypotension and separation of the retina in a patient dehydrated by prolonged diarrhea has been explained on this basis by Verhoeff and Waite.[20] The depressed fontanels of dehydrated infants and the temporary control of progressive hydrocephalus by administration of theobromine sodiosalicylate (Marriott [23]) are probably to be explained in the same way. The opposite effect can be found in the experiments of Kubie and Shults,[24] who noted a greatly increased flow of cerebrospinal fluid in dogs subsequent to large intravenous injections of nearly isotonic salt solution. The effect of this was to dilute the plasma proteins (thus promoting formation and at the same time diminishing absorption of fluid) without materially affecting the concentration of the inorganic constituents of the plasma. The venous pressure was no doubt raised by these injections, thus accentuating the effect.

When, on the other hand, the concentration in the plasma of such freely diffusible substances as sodium chloride, glucose or urea is

22. Weed (footnote 12). Duke-Elder (footnote 13).

23. Marriott, McK.: The Use of Theobromin Sodio Salicylate (Diuretin) In the Treatment of Hydrocephalus, Am. J. Dis. Child. **28**:479 (Sept.) 1924.

24. Kubie, L. S., and Shults, G. M.: J. Exper. Med. **42**:565, 1926.

changed, it might be thought that equilibrium between plasma and aqueous humor or cerebrospinal fluid would be reestablished at a new level so rapidly that marked changes in pressure would not occur. That this is not so has been clearly established by Weed and his associates [12] for the intracranial pressure, and by Duke-Elder [13] for the intra-ocular pressure. For detailed experiments well executed and for a careful review of the literature, the reader is referred to the publications of these investigators. Thus, the intracranial pressure may be reduced to many millimeters of water below the atmospheric pressure by intravenous or intraperitoneal injections of such substances, and the direction of fluid exchange through the choroid plexus may be reversed, as first shown by Foley [25] and recently confirmed by ourselves.[26] Distilled water, on the other hand, injected intravenously or into the gastro-intestinal tract, dilutes all the constituents of the blood, renders both the aqueous humor and the cerebrospinal fluid temporarily hypertonic to the diluted plasma, and thus facilitates the formation of fluid and decreases absorption. Marked increase in intra-ocular and in intracranial tension results. This mechanism is undoubtedly significant in the so-called "water intoxication" of Rowntree [19] (fig. 8).

Such striking effects on intracranial and intra-ocular pressure, produced by suddenly changing the plasma concentration of sodium chloride, glucose or urea, are to be ascribed to the great osmotic pressure exerted by these substances because of their relatively small molecular weight. These effects are not so surprising when one remembers that the cerebral venous pressure in man (horizontal position) amounts to only about 100 mm. of water, while the total osmotic pressure of the plasma is equal to more than 68,000 mm. of water. An increase in blood sugar of 50 mg. of glucose per hundred cubic centimeters will increase the osmotic pressure of the plasma by 650 mm. of water.

SUMMARY

The foregoing experiments show that, although the intracranial and the intra-ocular pressures are not directly dependent on one another, changes of hydrostatic or of osmotic pressure induced in the blood produce a parallel change in pressure in the eye and in the cranium, or, in the words of Claude Bernard, parallel "response to variations in the internal environment." These observations serve to emphasize again the similarity in the mechanisms for formation and for absorption of intra-ocular and intracranial fluids, and to indicate that these mechanisms are fundamental in the fluid exchange of the body.

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25. Foley, F. E. B.: Alterations in the Currents and Absorption of Cerebrospinal Fluid Following Salt Administration, Arch. Surg. **6**:587 (March) 1923.

26. Forbes, H. S., and Fremont-Smith, F.: To be published.

THE ACETIC ANHYDRIDE-SULPHURIC ACID TEST

FURTHER DATA ON THE BOLTZ CEREBROSPINAL FLUID TEST *

LEE D. CADY, M.D.
ST. LOUIS

The acetic anhydride-sulphuric acid reaction shows considerable promise of usefulness as a routine diagnostic measure on spinal fluids. It is a simple test, the nature of which is not understood, devised by Boltz [1] while making cholesterol studies on cerebrospinal fluids in neuropsychiatric patients. He was not satisfied with the test as specific for neurosyphilis, but considered it an indication of the destructiveness of *Spirochaeta pallida* on nerve tissue, or an index of the degeneration of nerve tissue. It was positive in all of twenty-six general paralytic patients; in six of fifteen tabetic patients; in five of seven cases of meningovascular syphilis; in one of eighteen cases of dementia praecox; in eleven of twelve cases of syphilis with other neuropsychiatric conditions; in two cases of arteriosclerosis, and in one of nine patients with manic-depressive psychoses.

In a comparison of the simpler laboratory tests with the Wassermann reaction in the diagnosis of neurosyphilis, Grossman [2] found that the chemical reactions were negative in all of the thirty-one tests of nonsyphilitic neuropsychiatric spinal fluid as well as in one case of tabes. The chemical reactions were all positive in twenty-nine general paralytic fluids giving Wassermann positive reactions, while the cell counts were variable. It is his opinion that the positive Boltz test is based on the presence of minute quantities of cholesterol, held in solution by the spinal fluid proteins of neurosyphilitic patients.

Harris [3] has published results with the spinal fluids of 180 patients. The Boltz test was positive in 97 per cent of the patients having general paralysis (ninety-two cases), in 80 per cent of neurosyphilitic patients (five cases), and in only 1 per cent of other neuropsychiatric conditions (eighty-three cases). He believes that it has a value equal to the Was-

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* From the Department of Neuro-Psychiatry, Washington University School of Medicine and Barnes Hospital.

1. Boltz, O. H.: Studies on the Cerebro-Spinal Fluid with an Acetic Anhydride-Sulphuric Acid Test, Am. J. Psychiat. **3**:111, 1925.

2. Grossman, S.: The Value of Simple Laboratory Tests in the Diagnosis of Neuro-Syphilis as Compared with the Wassermann Reaction, J. Mental Sc. **71**:439, 1925.

3. Harris, J. S.: A Simple Test of Diagnostic Value in General Paresis, Brit. M. J. **1**:136 (Jan. 23) 1926.

sermann reaction, and that it is perhaps more sensitive than the latter in certain cases. His results show that it is of equal importance with the cell count, colloidal gold reaction and globulin tests.

NATURE OF THE BOLTZ REACTION

The Boltz test is made by placing 1 cc. of spinal fluid in a Wassermann test tube and adding 0.3 cc. of acetic anhydride drop by drop. The contents of the tube are then shaken, and 0.8 cc. of concentrated sulphuric acid is added drop by drop. The tube is again shaken and observed for about five minutes, when a blue-pink or lilac color will develop in positive general paralytic fluids. Boltz believes that the test is of diagnostic and prognostic significance in neurosyphilis.

Some effort was made to determine the nature of the reaction. It was tested with a fairly large number of substances as controls. Since it is essentially a modification of the Liebermann cholesterol test, special attention was given this substance. One point was determined definitely: cholesterol in various amounts did not give a positive Boltz test. Glucose was also tested in various dilutions, but consistently gave negative results. Watery extracts of brain tissue and small bits of brain, brain lecithin, urea, uric acid, nucleic acid, calcium lactate and tyrosine also gave negative results. The experiments on these substances, however, were not extensive enough to allow any definite conclusion. Strongly positive fluids were then treated with ether, alkalis, nitric acid and hydrogen peroxide, all of which destroyed the lilac or violet producing substance. The proteins were precipitated with trichloracetic acid, heat and mercuric chloride. The precipitates were tested, and all gave a positive reaction. The trichloracetic acid filtrate gave a negative reaction. The substance is not dialyzable when the proteins are intact. It is not destroyed by peptic digestion, since the spinal fluid treated by peptic digestion still gives the reaction. The spinal fluids may be preserved for five or six months with chloroform without seriously impairing the positivity of its reaction. Contaminated fluids not older than from five to six weeks usually give just as strong reactions as sterile specimens.

Blood contains the lilac or violet producing substance. Spinal fluids contaminated with blood almost invariably give positive reactions. Syphilitic and nonsyphilitic serums will give positive tests. Generally the syphilitic serums will give the reaction in higher dilutions than nonsyphilitic serum. Not infrequently, one finds a nonsyphilitic serum that will give a stronger reaction in the dilutions used than certain syphilitic serums. One specimen of ascitic fluid in a nonsyphilitic patient gave a negative test.

The rapidity with which the concentrated sulphuric acid is added to the spinal fluid and acetic anhydride is important. It was noted that if the 0.8 cc. of acid was added rapidly enough to produce ebullition, a

positive reaction was more likely to result. Indeed, a single specimen will often give a negative reaction if the acid is added drop by drop, as in Boltz' original technic, and a positive reaction if the acid is added rapidly. As a test for syphilis, this modification in technic is probably a disadvantage, as it undoubtedly causes false positive reactions to occur. If the reaction is considered an index of meningeal and nerve tissue reaction, it is a valid modification.

MATERIALS AND ANALYSIS

A total of 799 specimens of spinal fluid have been tested by the modified technic. The results are set forth in the accompanying tables. Table 1 contains the data from all the cases of syphilis. It includes data on spinal fluids of patients in various stages of apparent clinical recovery from syphilis, a fact that accounts in part for the relatively smaller number of positive reactions in the general paralytic group. The modified technic probably accounts for the higher incidence of positive reactions in this group than in those found by other investigators. Even under these circumstances, the test was positive in from 74 to 87 per cent of known neurosyphilitic suspects, and some of these were known to have had syphilis with treatment. The data given here tend to substantiate Harris's [3] belief that the test is more dependable than the Lange colloidal gold reaction.[4]

When all the spinal fluids that were known to have been rendered negative were eliminated from the analysis, a higher percentage of positive reactions was obtained, from 79 to 94.6 per cent (table 2). Incidentally, the Boltz test was usually the last test to become negative in treated patients.

Neuropsychiatric conditions of nonsyphilitic nature gave positive reactions with the modified technic in 42.4 per cent of 264 patients It was also positive in a number of conditions in which inflammatory changes in the central nervous system were present or suspected. These positive reactions were found in such diseases as epidemic encephalitis, meningitis (tuberculous meningitis, 100 per cent positive) and retinal lesions. The modified reactions may also be positive in conditions supposedly of noninflammatory origin: epilepsy, hysteria, toxic psychosis, pernicious anemia, and tumors of the brain and spinal cord.

Certain nonneurologic diseases may also give positive reactions. The patients from whom the spinal fluid was obtained had sufficient neurologic symptoms to justify diagnostic examination of the spinal fluid.

4. In the tests I made, a colloidal gold reaction was arbitrarily considered positive if the plotted curve had more than three 2's or contained one 3, e. g., 01222210000 or 00123210000.

TABLE 1.—*Data of Examination of Spinal Fluid*

Diagnosis	Number	Blood Wassermann		Spinal Fluid Wassermann		Spinal Fluid Cells		Pandy Test		Colloidal Gold Test		Boltz Test						Totals		Per Cent	
		Positive	Negative	Positive	Negative	Above 10	Below 10	Positive	Negative	Positive	Negative	Clear	Brown or Yellow	Pink	Lilac	Violet	Purple	Negative	Positive	Negative	Positive
Syphilis	37	32	5	0	37	0	37	3	34	1	36	1	0	21	10	4	1	22	15	59.4	40.6
Syphilis of central nervous system (suspect)	53	21	32	0	53	1	52	14	39	3	50	0	3	23	18	7	2	26	27	49.1	50.9
Syphilis of central nervous system	166	94	72	108	58	80	86	87	79	92	74	4	9	30	45	72	6	43	123	25.3	74.7
Tabes dorsalis	102	41	61	60	42	47	55	60	42	44	58	1	4	21	38	37	1	26	76	25.5	74.5
General paralysis	100	78	22	87	13	44	56	64	36	81	19	0	2	11	26	57	4	13	87	13.0	87.0
Totals	458	266	192	255	203	172	286	228	230	221	237	6	18	106	137	177	14	130	328	28.3	71.6
Percentage		58.0	42.0	55.7	44.3	37.3	62.0	49.5	50.2	48.3	51.7	1.3	3.9	23.1	29.9	38.6	3.0				

TABLE 2.—*Data of Examination of Spinal Fluid After Fluids Rendered Negative Had Been Eliminated*

Diagnosis	Number	Blood Wassermann		Spinal Fluid Wassermann		Spinal Fluid Cells		Pandy Test		Colloidal Gold Test		Boltz Test						Totals		Per Cent	
		Positive	Negative	Positive	Negative	Above 10	Below 10	Positive	Negative	Positive	Negative	Clear	Brown or Yellow	Pink	Lilac	Violet	Purple	Negative	Positive	Negative	Positive
Syphilis of central nervous system	138	90	48	94	44	75	63	83	55	64	74	1	3	11	45	72	6	15	123	10.9	79.1
Tabes dorsalis	92	38	54	56	36	45	47	56	36	42	50	1	1	14	38	37	1	16	76	17.3	82.7
General paralysis	92	75	17	81	11	11	41	61	31	75	17	0	1	4	26	57	4	5	87	5.4	94.6
Total	322	203	119	221	101	171	151	200	122	181	141	2	5	29	109	166	11	36	286		
Percentage		63.0	36.9	68.6	31.1	53.1	46.8	62.1	37.8	56.2	43.6	0.6	1.5	8.6	33.8	51.5	3.4	10.7	88.7		

TABLE 3.—*Results of Tests of the Spinal Fluid in Nonsyphilitic Diseases*

Diagnosis Nonsyphilitic Neuropsychiatric Diseases	Number	Spinal Fluid Cells		Pandy		Colloidal Gold		Boltz Test						Totals	
		Above 10	Below 10	Positive	Negative	Positive	Negative	Clear	Brown or Yellow	Pink	Lilac	Violet	Purple	Negative	Positive
Totals	264	54	210	77	187	45	219	12	55	85	55	44	13	152	112
Percentage		20.4	79.6	29.1	70.9	17.0	82.6	4.5	20.8	32.2	20.8	16.6	4.9	57.5	42.4
Nonsyphilitic and Nonneurologic Cases															
Totals	77	5	72	18	59	4	73	3	19	34	11	9	1	56	21
Percentage		6.5	93.5	23.4	76.6	5.2	95.6	3.8	24.7	44.1	14.3	11.6	1.3	72.7	27.2

TABLE 4.—*Effect of Treatment on Boltz Reaction*

Diagnosis	No.	Initial Test				Final Tests Positive								Final Tests Negative			
		Positive		Negative		Stronger		Unchanged		Reduced		Negative		Unchanged		Became Positive	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
General paralysis	26	24	92.3	2	7.7	4	16.6	5	20.8	11	45.8	4	16.6	2	100.0	0	0
Tabes	20	13	65.0	7	35.0	2	15.3	4	30.8	5	38.5	2	15.3	4	57.1	3	42.9
Syphilis of central nervous system	32	28	87.5	4	12.5	1	3.6	3	10.7	8	28.6	16	57.1	4	100.0	0	0
Total	78	65		13		7		21		22		..		10		3	
Total percentage			83.3		16.6		10.7		36.9		33.8		....		76.9		23.1

These conditions included arthritis of the spine, hypertension, choroiditis, constipation, cholecystitis, deafness, diabetes, glaucoma, toxic erythema, hyperchlorhydria, aplastic leukemia, laryngopharyngitis, myocarditis, neoplasm, chronic nephritis, polycythemia vera, drug poisoning, sinusitis, toxemia of pregnancy, thyrotoxicosis and duodenal ulcer.

Arthritis of the spine gave a positive reaction in 63.6 per cent of the patients. If one considers the contiguity of the meninges and the spinal ganglia to the bony structures making up the intervertebral foramens, it seems possible that slight inflammatory changes may occur in the meninges in arthritis of the spine. One patient with a primary diagnosis of cholecystitis gave a positive test. She also had a definite but transient train of neurologic symptoms. The other patients could conceivably have had neurologic complications of an inflammatory or degenerative nature from the constitutional disease present.

The test may, like the Wassermann reaction, be reduced in intensity or rendered negative by antisyphilitic treatment. It also has become more intense in spite of treatment (table 4). Usually it is the last test to become negative with treatment. Insufficient data have accumulated in supposedly "cured" patients to justify a positive statement of its absolute worth as a prognostic indication. A patient with early tabes was treated until all routine clinical and laboratory signs were negative for syphilitic activity, and the man was discharged as possibly cured. He came back one year later with a recurrence of symptoms, and the spinal fluid was strongly positive. The data of the modified Boltz test showed that there had been a lilac reaction in the spinal fluid at the time of his discharge for observation. Since this incident, it has been the custom in the neurosyphilis clinic to continue treatment until the modified Boltz test is negative. Thus far, there has not been any cause to regret the additional treatment, which the patient receives before he is told that he may be free from syphilis.

SUMMARY

The Boltz test is a modification of the Liebermann cholesterol test, but these fragmentary observations fail to show that cholesterol is in any way responsible for the positive reaction. The modified Boltz test has been used on 799 specimens of spinal fluid. Positive reactions were found in from 79 to 94.6 per cent of patients with neurosyphilis when the test had not been rendered negative by treatment. The modified test was positive in 42.4 per cent of 264 other nonsyphilitic neuropsychiatric patients. It was found positive in 27.2 per cent of seventy-seven patients with constitutional diseases. This occurred for the most part in patients with arthritis of the spine. The original test seems

of some value in indicating the presence of abnormal processes in the meninges and the central nervous system, and promises to be of a value at least equal to other routine nonspecific chemical tests. The modified test may have considerable value in the control of treatment of neurosyphilis. These observations indicate that, whenever the test is used routinely, the original and the modified technic should be used on each specimen of spinal fluid examined.

Clinical and Occasional Notes

PROGRESSIVE NEURITIC MUSCULAR ATROPHY*

A. E. Kulkov, M.D., Moscow, U. S. S. R.

Although the problems concerning muscular dystrophies, particularly the neural ones, are for the moment being ignored, this chapter of neurology is not yet closed either symptomatologically or — and this cannot be emphasized too strongly — in the sense of its pathogenesis. In several recent articles, authors (Pette[1]) assert that, besides hereditary factors which are included among those causing the onset of neuritic muscular dystrophies, exogenous factors may also play a certain rôle. My observations concerning a case of neuritic muscular dystrophy of the Charcot-Marie type are of interest not only because of its clinical symptomatology (the case being atypical), but also because it brings up the question of the part played by oxogenous factors (lead in particular) in the development of the disease.

REPORT OF A CASE

History.—N., aged 36, a plumber, a native of Tula government, married, was admitted to the division for nervous diseases of the B. A. Obuch Institute on Oct. 23, 1925, complaining of weakness and wasting in all four extremities, difficulty in walking and drawing pains in the legs. The onset occurred in 1914, prior to which time he had enjoyed good health. Weakness appeared first in the right leg; six months later there was increasing weakness in the left leg, though he could still walk easily. No wasting was noted at that time. In 1921, weakness appeared in the upper extremities, first on the right side and soon afterward on the left. During this period there were no pains. Wasting was noticed for the first time in May, 1925; it appeared first in the legs and later in the arms. Changes in gait were noticed in 1924, before any atrophic phenomena; difficulty in walking increased in August, 1925. At the same time transitory rheumatic pains were experienced in the calves of the legs.

The family history did not reveal any indication of similar inheritance. The patient was born at term and developed normally. He drank moderately and smoked a little. The wife gave birth to one child who died shortly afterward, the cause of death being unknown; she had several miscarriages. The patient said he had not had syphilis and had not had any previous illness except gonorrhea in 1922. He worked as a plumber from the age of 26 (1915) until he entered the hospital.

Examination.—The patient was 169 cm. tall and weighed 67.3 Kg. The skin and mucous membranes were pale. There was a slight lead line on the gums. The cranial nerves did not deviate from the normal. The pupils were equal and reacted promptly to light and in accommodation.

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* From the Division for Nervous Diseases of the B. A. Obuch Institute for the Investigation of Occupational Diseases; Chief, Prof. S. N. Davidenkov.

* Read before the Neurologic and Psychiatric Association of the First State University of Moscow, Dec. 18, 1925.

1. Pette, H.: Zur Pathogenese der neuritischen Muskelatrophie, Ztschr. f. d. ges. Neurol. u. Psychiat. **92,** 1924.

In the upper extremities the muscle tone was decreased; active movements on the whole were full, except extension of the fingers (main-en-griffe, Aran-Duchenne hand); he was unable to perform any subtile movements. The muscular strength was fair excepting in the extensors and flexors of the fingers on both sides. The act of lifting the shoulders, their abduction and adduction, as well as flexion of the forearm were normal. The muscular strength on the right side was perhaps a little less than on the left. The rotators and supinators of the forearm were in normal condition and that of the extensors and flexors of the wrists was satisfactory. There was notable decrease of strength in the principal phalanges, especially on the right side; abduction and adduction of the fingers were slow, and in the thumb the muscular strength on both sides was zero.

TABLE 1.—*Electric Excitability*

	Faradic Current	
	Right	Left
Nervus medianus	.....	.....
Nervus ulnaris	.....	.....
Nervus radialis	.....	.....
Musculus flexor carpi ulnaris	Negative	Negative
Musculus brachioradialis	Negative	Negative
Musculus extensor carpi radialis	Negative	Negative
Musculus extensor digitorum communis	Negative	Negative
Musculus abductor pollicis	Negative	Negative
Musculus flexor digitorum communis		Decreased
Musculus flexor pollicis brevis	No contraction could be elicited (current to 15.0 milliamperes)	
Musculus abductor pollicis brevis		
Musculus abductor pollicis		CCC. 15 No contraction
Musculi interossei		
Musculus interosseus 1		

	Galvanic Current			
	Left		Right	
	CCC. Milliamperes	ACC. Milliamperes	CCC. Milliamperes	ACC. Milliamperes
Musculus interosseus 1	15	No contraction	18	No contraction
Musculus thenaris	10	No contraction	18	No contraction
Musculus palmaris brevis	5	6	10	No contraction
Musculus adductor pollicis	15	No contraction	18	No contraction
Musculus biceps		6		7
Musculus flexor carpi radialis	5	7		

	Faradic Current
Musculus biceps	No contraction could be elicited
Musculi interossei	Contraction
Musculus palmaris brevis	No contraction
	No contraction

	Galvanic Current			
Extensor digitorum communis brevis	18	20	20	25
Gastrocnemius	10	13	13	12
Tibialis anticus	25	0	20	20
Quadriceps	6	8	20	20

Atrophy was present in the interosseal muscles; the thenar and hypothenar muscles on both sides resembled a monkey's paw (flexion of the middle and terminal phalanges). Mechanical stimulation of the muscles could not be tested.

In the lower extremities active movements were full except extension, flexion, abduction and adduction of the feet (peroneal character of the paralysis). Slight extension of the foot was observed in the right foot. Both feet were dropped (pied-en-griffe). Muscular strength in the flexors and extensors of the knees and in the abductors and adductors of the legs was satisfactory. The muscles of the calves of the legs were wasted and flabby; the interosseal muscles were similarly atrophied. At the same time, a notable compensatory hypertrophy was present in the femoral muscles on both sides (the legs looked like bottles turned upside down). The extension and flexion of the feet, abduction and adduction of the ankles, flexion and extension of the toes, and abduction,

adduction and flexion of the principal phalanges were absent (the strength of the extensor and peroneal muscles being zero). In the upper extremities there was a certain unsteadiness in moving. In the lower extremities there was slight ataxia; the Romberg sign was positive.

The patient walked with stooping knees, the feet hanging loosely and with obvious "steppage" symptoms. The gait was ataxic-paretic. In standing the knees were bent, and the patient was unable to stand upright without a cane held in front of him. He could not stand on one leg. The attitude of the patient must depend on the plane of support. There cannot be any doubt that in this case there was simultaneous action of the extensors and flexors of the femur. The patient fixed his position by the aid of the quadriceps; in this way he succeeded in maintaining equilibrium. Facial expression was lively; there were no difficulties in speech.

Subjectively there was a chilly sensation and pains in the muscles of the calves. Objectively there was a decrease of tactile and temperature sensibility as well as hypesthesia of the upper extremities extending downward from the upper part of the forearm; in the lower extremities the sensibility diminished just below the knee and increased distally. The trunks of the nerves were not painful on pressure. Deep sensibility was apparently normal throughout. Vibratory sensibility on the left patella was from 5 to 6; in other parts of the lower extremities, this sensibility was well preserved. The eyegrounds were normal. Vision and visual fields were also normal.

The biceps and triceps reflexes were present on both sides; the ulnar and radial reflexes were also present and equal on the two sides. The knee jerks were sluggish, especially on the left. The ankle reflexes were absent on both sides. The abdominal, epigastric and cremaster reflexes were intact. Pathologic reflexes were not found.

As to vasomotor conditions, a chilly sensation was experienced in the distal parts of the extremities, especially in the legs, and there was a disposition to sweat.

The patient did not show any deviation from the normal mental reaction, nor was there any pathologic change to be found in the internal organs.

Tests revealed hematoporphyrin in the urine (from 0.5 to 0.7 mg. in a liter). The lead test with the blood was negative. The specific gravity of the urine was 1.030. No albumin or sugar was detected. Urates and squamous cells in the sediment were in excess of normal. The blood count revealed that the hemoglobin content was 74 per cent; there was no anisocytosis, polychromatophilia or erythrocytes with basophilic stippling; basophil cells were absent; there were 4 per cent of eosinophils; myelocytes and new cells were absent; there were 67 per cent of polymorphonuclear cells; 23 per cent of lymphocytes, and 5 per cent of transitional cells. The spinal fluid was clear and colorless and the pressure was not increased; no cells or globulin were noted. The colloidal gold reaction was 112221000.

COMMENT

The case is one of the neural forms of progressive muscular atrophy of the Charcot-Marie type, in which there is a number of atypical symptoms. The family history was unimportant; but in this point the case is not exceptional, as Pette reports a case in which hereditary factors were not found. Stiefler, who studied the material available up to 1906, reports that in 20 per cent of the cases, inheritance could not be traced.

As to differential diagnosis, it must first be emphasized that the condition is not a polyneuritis. The slow progressive course (eleven years from the onset of the disease) bears witness against this.

Among the atypical symptoms may be noted a rather uncommon peculiarity of gait (the patient walked with his knees bent). In the first article published by Charcot-Marie[2] on muscular atrophy of this type are some interesting points concerning similar peculiarities of gait. Charcot-Marie gives the explanation already mentioned and given by me before I had an opportunity to read the article mentioned. A brief abstract of the points follows:

CASE 1.—The onset of the disease was traced at the age of 5, the condition starting in the legs. At 7 years of age it spread to the arms and was followed later by atrophy of the leg in its lower part (5 cm. below the patella), atrophy of the distal parts of the forearms—"main en griffe"—and complete paralysis of the feet and fingers with diminished knee reflexes.

The author's description of the peculiarities of the upright attitude of the patient remind one in a striking way of those mentioned in my case.

Lorsqu'il veut rester immobile, cela lui est impossible á moins de s'appuyer avec les mains; sans cela il est dans un équilibre instable et est obligé pour ne pas tomber de piétiner sur place et de faire ses mouvements de fléxion et extension des jambes.

(The patient cannot stand firmly unless he holds on to some object with his hands. His balance is unstable; therefore, he flexes and extends the legs to avoid falling.)

In this case, just as in mine, there were symptoms of permanent flexion and extension of the knee joints in order to maintain the balance.

CASE 2.—The disease had had its onset in the legs of two brothers at the age of 3 or 4 years, beginning in the legs. Rapid wasting occurred in the knees and the distal parts of the thigh. Pes excavatus and "main en griffe" appeared with wasting of the distal parts of the forearm. Only a trace of flexion of the fingers and toes persisted. "Steppage gait" and fibrillary twitchings were noted. There were no pains. The knee reflexes were diminished. The description of the patient's attitude is as follows: "La station debout est difficile; le malade ne peut rester debout immobile, il est obligé pour garder l'équilibre de remuer constamment les pieds par une sorte de piétinement incessant et assez spécial.

(The patient has difficulty in standing erect and motionless. He is constantly shifting his weight from one foot to the other in the effort to maintain equilibrium.)

Here again are the same characteristic peculiarities of the upright attitude which are mentioned as "shifting from one leg to another " (piétinement).

The cause of this "piétinement" may be attributed to the disappearance of the muscles of the knee; as stated by Charcot-Marie, "l'articulation tibio-tarsienne n'ayant plus aucune fixité, les malles sont par rapport au pied dans un état d'instabilité très prononcée; ainsi l'équilibre est-il compromis et ne peut être conservé que par un mouvement de totalité de la jambe replaçant celle-ci dans une position plus covenable et ainsi de suite."

(The tibiotarsal joint is no longer firm; consequently there is instability of the legs. The disturbed equipoise requires the patient to be continually moving his legs, striving to obtain effective support from them.)

In connection with the problems of the pathogenesis of the neural form of muscular dystrophy, mention should be made of an article by Egger[3] in which he reports the cases of two brothers in whom the disease began in the lower

2. Charcot-Marie: Sur une forme particulière d'atrophie musculaire progressive souvent familiale, etc., Revue méd., 1886.

3. Egger: Beitrag zur Lehre von der progressiven neuralen Muskelatrophie, Arch. f. Psychiat. **29**, 1896.

extremities (on the right) spreading later to the upper extremities. Both patients had to deal with lead for a considerable period of time. According to Egger, lead intoxication is possible, and he presumes that, should it not be considered as an etiologic factor, lead poisoning may still be a precipitating factor for the development of the disease. Pette mentions several cases described in the literature in which the use of tea and coffee as well as some infectious diseases were considered as etiologic factors.

Returning to my case, I would emphasize that although the onset of the disease was perceived a year before the patient began to work with lead, later he used it in his work continuously until his admission to the Institute. When this point is considered, as well as the fact that my patient did show some symptoms (though slight ones) of lead poisoning, one may surmise that the lead poisoning was a facilitating exogenous factor in a certain stage of the disease.[4]

ADENOMA OF THE HYPOPHYSIS WITHOUT ACROMEGALY, HYPOPITUITARISM OR VISUAL DISTURBANCES, TERMINATING IN SUDDEN DEATH*

ESMOND R. LONG, Ph.D., M.D., CHICAGO

Sudden death due to symptomless adenoma of the hypophysis is probably rare. I have been able to find only one published report in which, by title, sudden death was correlated with the presence of a previously unsuspected tumor of this organ, although cases are on record in which death occurred more or less suddenly in patients known to have such tumors.

Clinical History.—The patient, a man, aged 37, was brought to the Illinois Central Hospital, on the service of Dr. L. H. Sloan, in a comatose condition at noon, May 17, 1926. He was a boilermaker, and had gone to work that morning apparently feeling in normal health. About 10 o'clock, he suddenly became dizzy and began to vomit. He walked to the office of the company physician, and a few minutes after his arrival went into coma. The physician, suspecting poisoning in view of the vomiting, washed the stomach out and administered aromatic spirits of ammonia. The patient did not revive and was sent to the hospital in an ambulance.

When first seen, his breathing was stertorous. The pupils were widely dilated and did not react to light. The pulse was slow, full and irregular, both in rate and in force. The blood pressure was 150 systolic, 90 diastolic. The Babinski sign was positive on both sides, particularly on the right. A specimen of urine obtained by catheter did not contain sugar or protein. Stomach washings were clear and had the odor only of aromatic spirits of ammonia.

The patient became increasingly cyanotic and died without regaining consciousness two hours after admittance to the hospital and four hours after the seizure in the morning. A clinical diagnosis of cerebral hemorrhage was made, but with uncertainty, in view of the meager clinical data.

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4. Davidenkov, S. N.: The Hereditary Diseases of the Nervous System, 1925.

* From the Department of Pathology, University of Chicago.

* Presented before a meeting of the Chicago Neurological Society, Dec. 18, 1926.

Postmorten Examination.—A necropsy was made on the same day. The body was that of a muscular, well developed and well proportioned man. The skin was of a yellowish, livid cyanotic color, not icteric. There was an abundance but not an abnormal amount of body hair. The subcutaneous fatty tissue was well developed, but evenly distributed and not excessive; the man was not obese. The head, feet and hands were of normal proportions.

The outstanding abnormalities noted on internal examination were a tumor replacing the hypophysis and an extensive fibroplastic pleural and lymphnodal tuberculosis. The heart was stopped in systole and was normal except for a hypertrophied left ventricle wall.

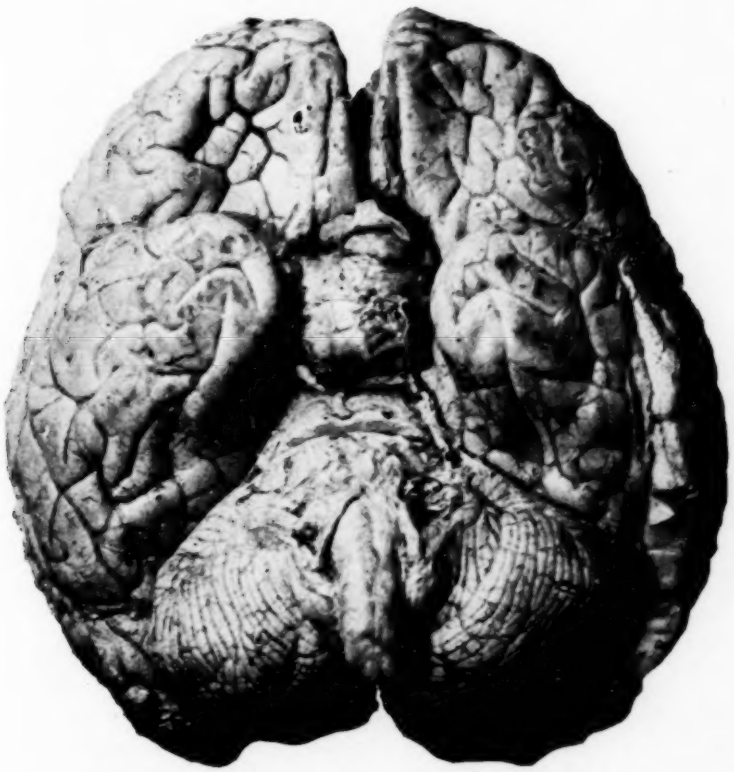

Fig. 1.—Base of brain, showing tumor of hypophysis.

I shall give in detail only those abnormalities noted in the examination of the brain. The dura did not appear to be under abnormal tension. The convolutions of the cerebral hemispheres were, however, flattened about equally on the two sides, and the sulci were narrow. A tumor mass projecting 2.5 cm. from the base of the brain was seen to replace the hypophysis. Figure 1 shows the appearance of the base of the brain after removal of the organ and fixation in solution of formaldehyde. The mass was lobulated and measured 4 by 3 cm. in its horizontal aspect. One lobule of the tumor projected directly into the sella, and another along the course of the left optic nerve. A small one touched the right olfactory nerve. Posteriorly, the tumor reached the bifurcation of the basilar artery into the posterior cerebral arteries, pressing on the anterior

part of the pons and the cerebral peduncles. Laterally, it compressed the temporal lobes lightly, and laterally and superiorly pressed on the separated optic thalami. The optic nerves were widely separated and compressed into ribbons 1 mm. thick and 1 cm. wide. The circle of Willis was intact, but was tightly stretched around the tumor. Aside from this stretching, the cerebral vessels were normal, except for moderate sclerosis of the right middle cerebral artery. There was no thrombosis or cerebral hemorrhage. No abnormalities were found in the brain tissue. The ventricles were of normal size, and the fluid was clear.

The sella turcica was increased in depth and length. The posterior clinoid processes were almost completely absorbed, and there was considerable reduction in the size of the anterior processes. The floor of the sella consisted of bare bone, not eroded, to which the tumor was adherent by delicate fibrous adhesions The overlying dural capsule was pushed up into the brain substance. The tumor was adherent to the dura by delicate adhesions anteriorly and firm connective tissue posteriorly. The left oculomotor nerve was bound down by these adhesions but apparently was not constricted.

On removal of the tumor from the depression that it had formed in the base of the brain, the floor of the depression was found to consist of dura in the posterior two thirds, while the anterior third was occupied by the flattened optic chiasma and optic nerves, the fibers of which were spread apart in places to a diameter of 1 cm. The optic chiasma was dislocated to the right. The right optic tract ran parallel to the longitudinal fissure, while the left crossed the floor of the depression to join it at an angle of 45 degrees. The course of the optic nerves was tortuous. The right turned back in its first portion, bent sharply and ran forward over the right anterolateral surface of the tumor. The left remained tortuous, but its fibers were spread widely apart as they crossed the anterior surface of the tumor.

Above the tumor, the fornix was flattened against the corpus callosum, and the space occupied by the septum pellucidum was obliterated. The third ventricle was flattened but patent.

In freshly cut sections the tumor tissue was grayish-brown, except for a region in the center of the right half, about 1.0 by 0.5 by 0.5 cm., in which there was softening. The rest of the mass was somewhat friable, but was of much firmer consistency than brain tissue. There was no hemorrhage.

Sections of the tumor were stained by the ordinary hematoxylin and eosin method, and also, through the kindness and interest of Miss Grace Hiller, by the neutral ethyl violet-orange G technic which has proved so fruitful in Dr. Harvey Cushing's clinic. The bulk of the tumor (fig. 2) was found to consist of columns or alveoli of epithelial cells of uniform size with deep staining nuclei and a moderate amount of cytoplasm, separated by a stroma rich in thin walled blood sinuses. In general character, the growth was adenomatous. The edge of the tumor mass contained compressed rows of cells representing remains of the original anterior lobe of the hypophysis.

The ethyl violet-orange G preparations showed the cells of the tumor to be uniformly of the chromophobe type, and a diagnosis of chromophobe cell adenoma of the hypophysis was accordingly made.

Microscopic sections of other tissues revealed other lesions (fibroplastic tuberculosis of pleura and peribronchial, mesenteric and peripancreatic lymph nodes), but no other abnormalities of interest in connection with the pituitary tumor. It is especially noteworthy that the testes were found to be normal, with abundant spermatogenesis.

In the lack of any other observations, I was forced to consider the pituitary tumor the cause of death. As the heart was contracted in systole, it is probable that death was due to respiratory failure rather than to failure of the heart. I have been able to find only one other report of sudden death in a person in apparently perfect health, attributed to a previously unsuspected tumor of the pituitary body. In 1913, Monro[1] reported the case of a boy, aged 20, who called the physician on account of severe headache. He had had mild headache off and on for ten days, but had remained at work until that day when he began vomiting and the headache increased in intensity. On physical examination the pupils were found widely dilated (as in this case) and responsive only to

Fig. 2.—Hematoxylin and eosin stain showing characteristic adenomatous structure of tumor.

strong light. The pulse rate was 60, and the temperature was 100.6 F. A diagnosis of meningitis was made. Death occurred two hours after the physician was called. On postmortem examination, the viscera of the thorax and abdomen were all found normal. The only abnormality was a large pituitary body, described as the size of a cherry and weighing about 75 grains (5 Gm.). On section the structure appeared to be normal (presumably, that is, like a normal pituitary body) except for edema and some small cysts. The meninges were edematous and the ventricles distended with fluid. Monro states: "The striking thing about this case was the fact that the young man was able to attend to his

1. Monro, J. D. R.: Lancet **2**:1539, 1913.

business on the day before he died, and his parents did not think of getting medical advice until two hours before the end." No explanation or theory as to how the tumor caused death is given.

Schloffer [2] has reported acute symptoms and sudden death in a man operated on two and a half months previously for pituitary adenoma. At necropsy a tumor mass not reached at the operation was found in the sella turcica, extending into the region of the foramen of Monro and through the genu of the corpus callosum. Death in this case was attributed to an acute increase in the hydrocephalus already present as a result of tumor pressure on the foramen of Monro and third ventricle. The ventricles contained 200 cc. of serous fluid.

In the case I have described no appreciable degree of hydrocephalus was present, as in Schloffer's case. I am not sure what was the actual cause of the sudden death, but am inclined to attribute it to direct pressure on the brain stem. There was no hemorrhage in the tumor or in the brain nor hernia of the brain into the foramen magnum to account for the suddenness of the acute symptoms, and I can only imagine that sudden increase in blood pressure in the course of heavy manual labor was the "straw that finally broke the camel's back," and precipitated the attack.

In view of the nature of the tumor and the compression of the optic nerves and chiasma found at necropsy, an attempt was made to learn from the family if any symptoms such as are commonly found in pituitary adenomas were present, and also if the man complained of disturbance of vision. Although the wife was highly cooperative, little significant information was obtained. To her he was a man in perfect health. No change in bodily appearance which could be interpreted as a manifestation of either hyperpituitarism or hypopituitarism had occurred. She gave no reason to suspect that any change in her husband's sexual feeling had taken place. He was the father of three children, the youngest being 5 years old. She insisted that he had no difficulty in seeing, and cited as proof the fact that he was teaching their youngest child to read. She stated that he had occasional headaches, but believed they were no worse than her own. He was getting medicine at the drug store for his headaches.

Dott and Bailey [3] have recently reviewed the large experience of the Harvey Cushing clinic in pituitary tumors, and state that visual disturbance is the most frequent cause leading the patient to seek medical advice. Nevertheless, as many authors have emphasized, large tumors may exist with only slight visual symptoms. Walker and Cushing [4] state their belief that almost as much individual variation exists in tolerance to pressure on the optic nerves as in tolerance to such toxic agents as alcohol and tobacco. They cite several cases of large tumors of the hypophysis with acromegaly, in which considerable distortion of the chiasm existed without obvious visual defects or even imperfection of the visual fields. De Schweinitz [5] accounts for the absence of hemianopia in certain cases of large adenoma of the hypophysis, and its presence in others, on the basis of frequent variation in the relation of the hypophysis to the chiasm. Lloyd and Grant [6] cite a case of exceptionally large

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2. Schloffer: Wien. klin. Wchnschr. **20**:1075, 1907.

3. Dott and Bailey: Brit. J. Surg. **13**:314, 1925.

4. Walker and Cushing: Arch. Ophthal. **47**:119, 1918.

5. De Schweinitz, quoted by Cadwalader in discussion of paper by Lloyd and Grant.

6. Lloyd, J. H., and Grant, F. C.: Tumor of Hypophysis, Arch. Neurol. & Psychiat. **12**:277 (Sept.) 1924.

adenoma of the hypophysis (9 by 5 cm.) extending as far back as the cerebellopontile angle, in which symptoms of any kind were slight. They state that it was "strange that it did not cause complete blindness early," and give as the probable explanation that the main part of the tumor lay somewhat behind the chiasm.

Hirsch,[7] in discussing 100 cases of pituitary tumor in which operation was performed, divides them into benign and malignant, with visual disturbances constituting the clinical sign of a malignant condition. The malignant group progress more rapidly, growing upward and forward, soon compressing the chiasm and stretching the circle of Willis to the point at which it strangulates

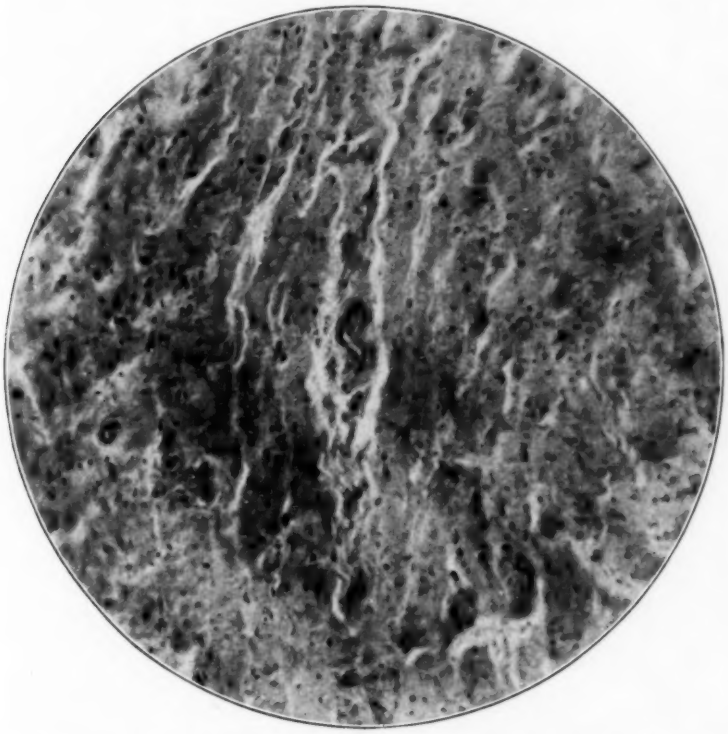

Fig. 3.—Hematoxylin and eosin stain of cross-section of left optic nerve, showing flattening of fibers.

the optic nerves, preventing free access of cerebrospinal fluid into the sheath. The benign group may cause acromegaly or hypopituitarism, but are slow growing, with a tendency to extend toward the base of the skull, leaving the chiasm floating free above. Hirsch considers the visual disturbance rather than the symptoms of pituitary dysfunction the indication for operation.

In the case that I have reported, there can be little doubt that accurate clinical observation would have detected changes in the visual fields before death. It is of course well known that impairment of vision may progress so insidiously that the patient adapts himself to the change unconsciously, and

7. Hirsch: Presse méd. **34**:578, 1926.

compensates for the loss of sensitiveness of certain fields of vision by moving the head. In this case the optic nerves were profoundly compressed. Figure 3, taken from a cross-section of the left optic nerve, stained with hematoxylin and eosin, shows the marked flattening of the individual fibers (compare with the normal, fig. 4).

The absence of symptoms referable to disturbed endocrine function in this case is equally noteworthy. The tumor is strictly of the chromophobe cell type. Figure 5 shows a section of the tumor and capsule stained with neutral ethyl violet and orange G. In the capsule a number of chromophilic (eosinophilic type) cells are seen, which represent remains of the anterior lobe of the old

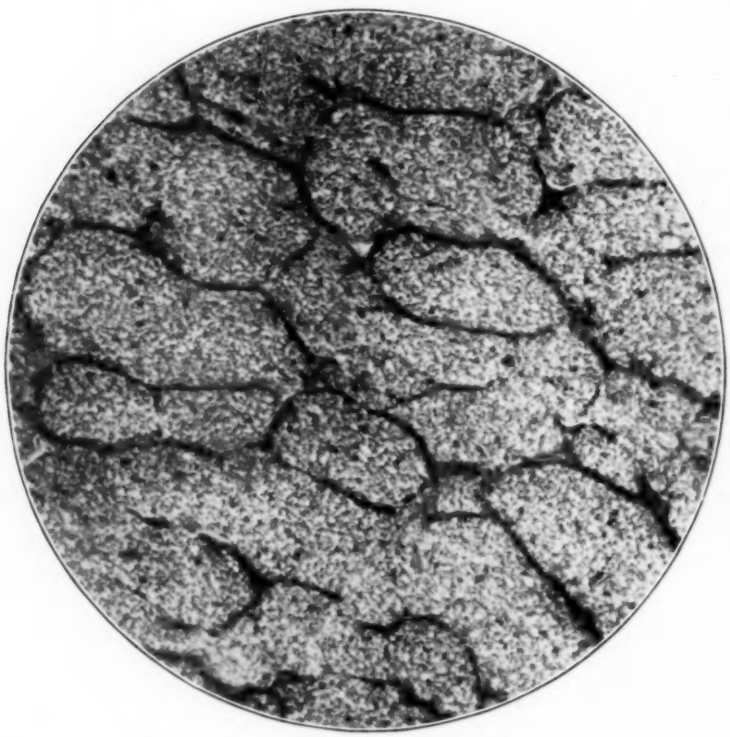

Fig. 4.—Hematoxylin and eosin stain of cross-section of normal optic nerve, for comparison with figure 3.

hypophysis. The alveoli of the tumor are composed entirely of chromophobic cells. According to Cushing and his colleagues, purely chromophobe adenomas, which in their opinion may be functional hyperplasias rather than true tumors, are associated with hypopituitarism and never with acromegaly. Dott and Bailey, reviewing 162 hypophysial adenomas seen in the Cushing clinic, state that depression of sexual function is almost constant for all types of hypophysial adenoma. They have seen only two exceptions in chromophobe cell adenomas.

Acromegaly, according to the Cushing school, is the result of excessive proliferation of the eosinophilic type of cell. They believe that the granules in the eosinophilic cells of the normal gland are concerned with normal growth.

The tumor that I have described did not contain any cells of this type, and on the basis of this conception would not be expected to give rise to acromegaly. On the other hand, the characteristic symptoms associated with the chromophobe type adenoma were also lacking. The man, while provided with plenty of subcutaneous fat, was of a muscular and not obese type. The skin was not atrophic nor was the hair scanty. If anything, the hair in distribution and amount corresponded with the picture given by Dott and Bailey for the acromegalic type. The tumor was not of the mixed type that these authors

Fig. 5.—Neutral ethyl violet and orange G stain of tumor. The dark cells (chromophilic) are remains of the normal hypophysis. The pale cells (chromophobic) are from the bulk of the tumor.

describe. Although a detailed sexual history of the patient was not available, nothing suggesting sexual depression was elicited on questioning the wife. More important than this, the testes were absolutely normal in gross and microscopic appearance.

DISCUSSION

DR. PETER BASSOE: Dr. Long has presented this case beautifully and has anticipated any question that I might ask. Sudden death is common in tumors of the brain of all kinds — sudden death is not explained by any particular

event such as hemorrhage. It is largely a problem of cranial dynamics or mechanics. Dr. Long made it clear that this man had none of the ordinary signs that go with a pituitary adenoma of the chromophobe type. I was thinking particularly of the thin, wrinkled condition of the skin that Cushing had described.

Dr. Sigmund Krumholz: I wish to corroborate the statement made by Dr. Bassoe by describing a patient I saw about two weeks ago in the Cook County Hospital. The man was under observation in the hospital for some time. When I saw him recently, I could find nothing to suggest danger to his life. Two days later he died, and at autopsy a tumor in the frontal region was found. This again illustrates the fact that a patient with cerebral tumor may die suddenly without showing any evidence of the seriousness of the condition.

Dr. D. M. Olkon: I should like to cite an interesting experiment made by Professor Sheehan. He took small rubber balls that could be inflated and distributed them through the brain tissue of dogs and cats. He would insert one of these and would see whether he could localize it after pressure was applied. It would be found many centimeters from where the ball was applied. From the pressure exerted, he received the impression as though the cerebellum was involved or again as though the midbrain was affected. It is always believed that the patient dies suddenly from lack of respiration. This experiment has shown how the different parts of the brain respond to air.

Dr. Roy Grinker: May I ask if any morphologic changes were found microscopically in the midbrain or brain stem, which could account for the sudden death?

Dr. Long: I am aware of the fact stated by Dr. Bassoe that sudden death is not rare in tumors of the brain. The mechanism is not entirely explained, although occasionally an acute hydrocephalus or hemorrhage appears to be the cause, as was brought out in the discussion. In the great majority of these cases, it has been known during life that the patient had a tumor of the brain. In many there were projectile vomiting or visual symptoms, so that a tumor of some sort was diagnosed. In these cases, as Dr. Bassoe said, it is not uncommon for sudden death to occur. This patient, as far as the family knew, was healthy. He had an extraordinary amount of tolerance to the tumor. It was equaled only by the tolerance to the tuberculosis that he had.

I hoped that some one might enlighten me as to how much pressure the optic nerve can stand without visual disturbances resulting. It must have been high in this case.

PSYCHOSIS IN A CHILD AGED SEVEN YEARS*

Henry H. Hart, M.D., Greenwich, Conn.

The occurrence of psychoses with hallucinatory and delusive content in children is sufficiently rare to justify reporting the following case, which is not sufficiently differentiated to permit exact classification.

Clinical History.—A Jewish boy, aged 7, was a full-term child and weighed 9 pounds at birth. The mother had had much pain and vomiting during this,

* From the service of Dr. T. H. Weisenburg, Philadelphia Infirmary for Nervous Diseases.

as during her other pregnancies. Fetal movements had been active. Parturition was of seven hours' duration and was not difficult; there was no asphyxia. The child was nursed at the breast until 14 months of age. He cried a great deal more than the other children; sleep was irregular, and he required the breast or singing of his mother to put him to sleep. Up to the age of 9 months, the digestive functions were disturbed by colic, but not afterward. He never showed changes suggestive of rickets, and dentition was regular and normal after the age of 1 year. He held his head up at the age of from 6 to 8 months, and began to creep at 1 year. Talking commenced between the first and second year. There were no convulsive seizures and no marked temper tantrums at any time.

The patient showed well marked activity in play at the age of 2 years, when he played with his sister and enjoyed listening to stories. In play, he seemed definitely less active than normal children and made more demands on the mother's care. He had always been bashful with strangers, and it had always been difficult to get him to talk. He was troubled with poor appetite. He showed no unusual tendency to make-believe in play and no special richness of imagination. There was no unusual intensity of like or dislike, and he seemed to have a long enough contentment span. Toward the mother he was affectionate and thoughtful, wanting to help her and pitying her when she had to wash the floor. He showed little interest in other children, his sole playmate being a girl about one and one-half years younger than himself; of boys of his own age he seemed definitely afraid, running home with tears on the slightest teasing. Intellectual curiosity was about average and showed no special direction. He was always obedient and gave no trouble to his parents in the matter of discipline. His possessive cravings were about average, and he never persisted in wanting things the parents refused.

The onset of the symptoms of the psychosis preceded going to school in September, 1925, by about two months. He did not get on well at school because he would not pay attention to directions, but would sit quietly in his seat, apparently day-dreaming. When spoken to by the teacher, he never seemed to pay attention to what was said, and when told to recite a lesson, he would merely stand up and say nothing. He never learned his lesson and was therefore never promoted. He was so quiet that the other boys called him "sissy," which caused him to go home crying. He would not play with other boys for this reason. Except for measles at the age of 5 and a rash on the face in June, 1926, which the mother considered was chickenpox, the patient has had no illness of note.

The father is a stolid Russian Jew, about 36 years of age, a shoemaker by trade. He is even-tempered and domesticated, and has never beaten or frightened the children. The mother is affectionate and shows the usual maternal anxiety over the children. There are two siblings—a sister, aged 11, in the fourth grade at school, and an infant, aged 14 months. Careful review of the family history fails to elicit any instances of nervous or mental disease.

The manifest psychosis began in July, 1925, when the mother first noticed, after he had gone to a moving picture theater with a small girl playmate, that the patient would at times talk in angry terms to an imaginary person. He cried, "Stop it, go away!" and made gestures with his arms, as if fighting with some one. When the mother, with the aim of distracting him from these maneuvers, took him for a walk, he would continue to make these hostile gestures. When asked whom he was fighting, he replied "They are hitting me," and when asked "who?" answered "The Indians." For four weeks he remained in constant fear of some combatant. He slept poorly at night and

would wake every now and then to cry or laugh. He would not, however, impart to his mother what he was crying or laughing about. He declared that he could not sleep because "they were hitting him." There was no history of fever, unusual lethargy or diplopia at this time, and the patient was not suffering from any acute somatic disease as far as could be determined. The appetite, however, was poor. The mental condition gradually improved and the boy remained fairly well until about Sept. 4, 1926, when he again began to grow "nervous." He began to sleep poorly and ate little. He told his mother that "boys were hitting him." Often, he would go about by himself, refusing to speak to any one, and would lash his arms about at imaginary foes. He would sit by himself frequently and giggle, but gave no reason for this to his mother. When running around with other children at play, he was unusually easily exhausted, became red in the face and perspired profusely. Often he would sit still and take no notice of what went on about him or of what his parents said to him. He mentioned no particular boys' names. It was in this state of mind that he was brought to the hospital.

Mental Status.—Since admission to the hospital in September, 1926, the patient has been shy and inactive. If left in any part of the ward he tended to remain there indefinitely without apparent desire to move away or indulge in games. He at first showed little spontaneous interest in anything, and was disinclined to play with the other children in the ward, except under continual coaxing. When told to do anything, he would promptly do it; he showed at no time any tendency to disobedience or stubbornness. He acted much like a child who is exhausted. When spoken to, he would often not reply until the question had been repeated many times, and then, as if with an effort, he would answer in a low, almost inaudible voice. The withdrawal from home did not seem to cause much emotional turmoil, and when, after four weeks, he was allowed to see his mother, he accepted her caresses without any emotion whatever and scarcely a smile. In his attitude toward her and toward the nurses and doctors, there was extreme shyness and indifference, although with the other children in the ward he gradually came to show less restraint. He has not, since admission to the hospital, shown any disorientation as to person or place, and orientation as to time was good. Although special attention was given to hallucinatory experiences, he gave little evidence of these while in the hospital. He was observed several times to talk and smile to himself. On one occasion he was asked what he was thinking of, and he replied "Mother." On another occasion he spoke of a pin being put in his bed, but showed no emotional excitement. Since admission to the hospital, there have been no night terrors or nightmares.

A psychometric examination gave him a mental age of 6 years 8 months. The psychologist saw no evidence of serious intellectual defect, and considered the disturbance as chiefly emotional.

Physical Examination.—The boy was undernourished and of sallow complexion. His movements were always slow and weak. As he sat or stood, the head frequently fell back as if he lacked strength to hold it up. The skin showed a pigmented mole over the anterior aspect of the neck and a general excess in the amount of body hair for a boy of this age. Examination showed the lymphatic and respiratory systems to be normal. The heart rate was abnormally slow — about 60 a minute — but was regular and of good volume. There were no heart murmurs. Circulation in the extremities was defective. The pulse response to effort and standing was good. The weight on admission was 45 pounds (20.4 Kg.) and has remained more or less constant.

Laboratory and Special Examinations.—These examinations reveal little in the way of pathologic change, although the roentgen ray showed an accessory joint in the first rib on the left side near the left of the scapula, evidently a congenital defect. The thymus was not enlarged. The lungs showed some peribronchial and hilum infiltration with slight accentuation of the lung field, which was not considered enough to warrant a diagnosis of tuberculosis. The sella turcica was normal in size. The urine was normal. The red blood cells numbered 4,470,000; the white cells, 7,800, and the hemoglobin was 75 per cent. Glucose tolerance was normal. Studies of the blood chemistry showed nothing abnormal. The basal metabolic rate was minus 3. The blood Wassermann reaction was negative.

Comment.—In reviewing the literature on psychoses in childhood, one is impressed by the paucity of cases. Rhein was able to collect reports of only forty-four cases in the literature and Strecker, in a review of 500 consecutive cases of psychoses, found only eighteen instances in children under 15 years of age. Of these, ten were finally diagnosed as manic-depressive in type, while in only four was the suggestion of dementia praecox made. The latter disorder according to most authors — Ziehen, Alexander and others — begins at or about puberty. The majority of psychoses in children occur in association with some infective process and have the form of a delirium with hallucinations, illusions and simple delusions.

The case reported here does not lend itself easily to classification. The lack of energy, ready fatigability and inadequate nutrition make one confident that there is some organic process, some constitutional deficiency, at the basis of the disorder, which cannot, by the present means of diagnosis, be discovered. The child has been handicapped by a lowered capacity for nutrition, and although his past life had been free from serious infectious diseases, he had been unable to compete or hold his own with average healthy boys of his age. This may in some measure account for the timidity and the gradual satisfaction obtained in fantasy and seclusiveness. The rich autistic life of children makes one wonder if all these instances of hallucinatory character may not be rather the outcome of vivid imagination and fantasy in a seclusive and sensitive child, rather than indications of a more malignant process possibly terminating in dementia praecox.

THE NEUROPATHIC TAINT IN MIGRAINE

WILLIAM ALLAN, M.D., CHARLOTTE, N. C.

With the many excellent clinical descriptions of migraine from the past century, there have come various statements that are still repeated in almost every account of this malady, apparently because of their age and the authority derived from constant repetition, rather than because of any evidence to substantiate them. One such idea is that a migrainous person has a neuropathic constitution, inherited from neuropathic ancestors; this idea has recently been reiterated by Bramwell,[1] who says that "migraine occurs notably in families with a neuropathic taint." Auerbach[2] says that "most migraine patients also belong to the primarily nervous, although every experienced neurologist will

1. Bramwell, Edwin: Discussion on Migraine, Brit. M. J. **2**:765 (Oct. 30) 1926.

2. Auerbach, S.: Headache, Oxford Medical Publications, 1913, p. 36.

know families in which migraine is endemic without there being other more definite manifestations of neurasthenia or hysteria." This statement is equivalent to saying that migraine is one of the manifestations of neurasthenia and of hysteria. Riley,[3] in speaking of migraine, says, "Nearly always there is a history of nervous disorders in the family. Sometimes in the ancestors migraine alternates with epilepsy, hysteria, and certain forms of insanity."

Timme[4] says, "It need not be assumed, however, as indicated by most textbooks, that the hereditary factor must be migraine itself. In the experience of the writer this is but one of a number of symptoms which merge into one another, are metamorphosed in passing from parent to offspring, and arise in quite different form in various members of a family. This group of symptoms comprises epilepsy, glycosuria, giantism, carcinoma, asthma, urticaria, the arthritides and Raynaud's disease." Reilly,[5] after saying that in at least 75 per cent of the cases there is a distinct hereditary history, further says that "the family history in many cases is equivocal, either a history of epilepsy or of migraine, or often of both in the family history." Christiansen,[6] in discussing the incidence of the heredity of migraine, says that it will be 100 per cent if one includes neuropathic heredity, such as the neuro-arthritic diathesis of Charcot and the heredity of the psychoses and psychoneuroses. Edinger[7] says, "When migraine is unknown among other members of the family, we often ascertain that other neuroses have appeared in the family, especially epilepsy, congenital degeneration and neuralgia." Osler[8] says, "Women and the members of neurotic families are most frequently attacked."

It is evident, therefore, that many leading authorities consider a migrainous subject as being neuropathic with neuropathic inheritance. Furthermore, to some observers the psychoses, psychoneuroses, epilepsy and migraine in previous generations have an equal value from the standpoint of heredity, and these maladies may be substituted for one another in the inheritance of later generations.

What is the evidence from which these authorities have concluded that in migraine there is a neuropathic taint? Considering the high incidence of migraine in the adult population, which is given by Riley as 50 per cent of women and 25 per cent of men, is it surprising to find migraine closely associated with all other conditions? Charcot found neuropathic and migrainous heredity closely associated. Weeks[9] found epilepsy and migraine closely associated in hereditary studies. Would not the same close association be found between migraine and all other diseases in which there is a hereditary factor, such as diabetes or cardiovascular disease?

To show that "migraine occurs notably in families with neuropathic taint" would seem to require that a series of neuropathic families be compared with a series of nonneuropathic families in regard to the occurrence of migraine.

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3. Riley, W. H.: Headaches, Good Health Publishing Co., 1916, p. 29.

4. Timme, W.: Nelson Loose Leaf Medicine, 1920, vol. 6, p. 654*A*.

5. Reilly, T. F.: Headache, Philadelphia, P. Blakiston's Son & Co., 1926, p. 228.

6. Christiansen, V.: Rev. neurol. **1**:854 (June) 1925.

7. Edinger, L.: Modern Clinical Medicine, Volume on Nervous System, New York, D. Appleton & Co., 1909, p. 871.

8. Osler, W.: Practice of Medicine, New York, D. Appleton & Co., 1905, p. 1066.

9. Weeks, D. F.: Tr. First International Eugenics Congress, London, Charles Knight & Co., Ltd., 1912, p. 34.

While my observations do not support this opinion, it seems unnecessary to offer statistical evidence in rebuttal until some specific evidence is published in affirmation.

To demonstrate that migraine is a symptom of epilepsy, the psychoses and the psychoneuroses or that it alternates, or is interchangeable, with these conditions would seem to require that migraine be found more frequently in such neuropathic persons than in others, or that these neuropathies be more frequent in the migrainous than in the nonmigrainous person. For the sake of examining this problem statistically, I have tabulated 4,000 consecutive case histories of all sorts for comparison with 400 cases of migraine.

The incidence of epilepsy in 4,000 patients seen consecutively was 0.85 per cent, while in 400 migrainous patients seen consecutively, epilepsy was coincident in 0.75 per cent. These are, it is true, few examples, but my figures approximate those of Clark,[10] who gives from 0.20 to 0.33 per cent as the incidence of epilepsy in the general population. There has been nothing in my experience to suggest any organic relationship between epilepsy and migraine in the same person; in the cases of migraine I have never seen epilepsy as a symptom of, or interchangeable or alternating with, migraine. From the clinical standpoint, therefore, I hold with Christiansen and Vallery-Radot[11] that the similarity between the two is only superficial.

When the same material was used for comparison, the incidence of the psychoses in 4,000 consecutive cases was 1.8 per cent, while in 400 consecutive cases of migraine it was 1.75 per cent. The psychoneuroses, only the pronounced forms of which have been listed in the diagnoses, occurred with the frequency of 4.7 per cent in the general run of cases and 4 per cent in the 400 cases of migraine. These figures have only a comparative value, as there is a large personal equation in the diagnosis of these neuropathies and no single clientele is drawn proportionately from all classes of the population; but, judging by experience in the field of internal medicine, in which the patients having migraine come from the same sort of people as all the rest of the patients and are seen under the same conditions, there is nothing to indicate that epilepsy, the psychoses or the psychoneuroses occur more frequently in the migrainous than in the nonmigrainous person.

That migraine may appear as epilepsy in one generation, and as a psychosis or a psychoneurosis in the next, or vice versa, should be susceptible of statistical proof, but is such evidence forthcoming? Myerson's[12] work tends to show that the psychoses are transmitted as such from generation to generation. There is nothing in my experience comparable to the observations of Weeks that 26 per cent of the offspring from matings in which at least one parent was migrainous are epileptic. I have not found more epilepsy among the children of migrainous parents than among the children of nonmigrainous parents, and the epileptic patients, almost without exception, have given a history of epilepsy in ancestors or collateral branches. On the other hand, there is the strongest statistical evidence to show that: (1) migraine in a child comes directly from migraine in one or both parents, such history being obtained in 91.7 per cent of the cases; (2) migraine is transmitted as migraine and not as anything else. In my series, when both parents were migrainous 83.5 per cent of the children were migrainous; when one parent was migrainous 57 per cent of the children were migrainous.

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10. Clark, L. P.: Osler's Modern Medicine, ed. 2, 1915, vol. 5, p. 592.
11. Vallery-Radot, P.: Rev. neurol. **1**:881 (June) 1925.
12. Myerson, A.: The Inheritance of Mental Diseases, Baltimore, Williams & Wilkins Co., 1925, p. 336.

SUMMARY

1. Psychoses, psychoneuroses and epilepsy occur with the same frequency in migrainous as in nonmigrainous persons.

2. Migraine has not been observed to come from anything but migraine in the parents, nor to pass down to the children in any other form. More than 90 per cent of my migrainous patients give a history of migraine in one or both parents; with one parent migrainous, half the children have been found migrainous; with both parents migrainous, more than three fourths of the children have been found migrainous.

3. Migraine seems to be a condition entirely independent of the neuropathies here mentioned, and its inheritance seems to be as free of neuropathic taint as the inheritance of color of the eyes.

HEXYLRESORCINOL AS A CEREBROSPINAL ANTISEPTIC*

H. P. Schenck, M.D., Philadelphia

As methenamine, commonly used as a urinary antiseptic, has acquired some vogue as a cerebrospinal antiseptic, it was thought that hexylresorcinol, a new urinary antiseptic, might be eliminated in the cerebrospinal fluid when taken by mouth. It had been pointed out that, since methenamine was effective only in an acid medium, its value in the neutral or faintly alkaline cerebrospinal fluid was questionable. In hexylresorcinol, on the other hand, one has a drug possessing antiseptic properties regardless of the acidity or alkalinity of the medium in which it is dissolved.[1]

A further advantage in the use of hexylresorcinol lies in the fact that the less fluid ingested, the greater the effect of the drug, at least as far as the urinary tract is concerned. Veader Leonard and Austin Wood[2] have shown that hexylresorcinol is a powerful surface tension reducent. Its remarkable bactericidal power is probably largely dependent on this physical property. In postoperative cerebrospinal leak and in certain cases of tumor, it is highly undesirable to push fluids. The danger of increasing an intracranial pressure, already at dangerous heights, by giving fluids freely is obvious. Theoretically, hexylresorcinol would be most potent in cases in which the fluid intake was at a minimum. If liberated in appreciable amounts, it would serve as a valuable preoperative and postoperative prophylactic.

The use of the drug by direct injection into the spinal canal of rabbits was found to be out of the question, since the animals so injected immediately developed paraplegia and convulsions, and died within twenty-four hours. The cord, at autopsy, showed wide-spread destruction and softening.

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* From the William Pepper Laboratory of Clinical Medicine and Department of Neuro-Surgery, Clinic of Dr. Charles H. Frazier, Hospital of the University of Pennsylvania.

1. Leonard, Veader: Secretion of Bactericidal Urine and Disinfection of the Urinary Tract Following the Oral Administration of Certain Alkyl Derivatives of Resorcinol, J. A. M. A. **83**:2005 (Dec. 20) 1924.

2. Leonard, Veader; and Wood, Austin: The Present Status of Hexylresorcinol as an Internal Urinary Disinfectant, J. A. M. A. **85**:1855 (Dec. 12) 1925.

The lack of a satisfactory test for the drug in body fluids at first prevented the demonstration of hexylresorcinol in the cerebrospinal fluid following administration by mouth. In August, 1925, a test for hexylresorcinol in body fluids came to my attention. This test, devised by D. C. Elliott and H. G. Barbour,[3] is a modification of one of the tests given in the U. S. Pharmacopœia for resorcinol. It consists of adding to 2 cc. of the fluid to be tested 0.25 cc. each of 40 per cent potassium hydroxide and chloroform. This mixture is boiled gently until one minute after the chloroform has been driven off. A pink color, usually strongest after standing five minutes, develops when hexylresorcinol is present. An unboiled control test should be performed when doubt exists as to the development of the color. Elliott and Barbour state that in distilled water hexylresorcinol can be detected in dilutions of 1:100,000; in urine, 1:50,000, and in serum, 1:25,000. A 1:5,000 dilution of hexylresorcinol added to bile imparts a pink color to the foam after the reagents have been boiled.

I found the test more satisfactory if the fluid to be tested was first evaporated almost to dryness on a water bath and the reagents then added. A cherry red color develops if appreciable amounts of hexylresorcinol are present. This modification interferes somewhat with colorimetric comparisons. In heating spinal fluid over the water bath, a coagulum usually forms. This covers the surface, but may readily be removed by filtering. Further heating produces an annoying green tinge to the fluid, but I have been able to overcome this. The cherry red color, if present, can be seen in spite of this.

In 9.56 per cent of the spinal fluids from patients receiving hexylresorcinol, faint traces of the drug have been obtained by such color reactions. A strong reaction, such as occurs in urine or in solutions in distilled water has never been obtained. None of the patients in whom a positive test was obtained had received the drug in amounts less than 15 grains (0.9 Gm.) daily for five days. The strongest reactions occurred in fluids from patients receiving the drug for more than a week in doses of at least 15 grains daily.

Growth was almost invariably obtained on inoculating spinal fluid from patients with streptococci and staphylococci who had been given hexylresorcinol. Since growth of ordinary skin cocci and occasional spore formers had frequently been found in fluids taken under average precautions from normal persons, a large number of specimens of spinal fluid brought to the laboratory from various sources were incubated. This has been done with 422 specimens, 287 of which came from persons who had never received hexylresorcinol, and 165 from persons who had received it by mouth for periods ranging from forty-eight hours to two weeks.

Of the 287 specimens from patients who had not been given hexylresorcinol, 158, or slightly more than 55 per cent, showed a growth after incubation at 37.5 C. Of the 165 specimens obtained from patients who had received hexylresorcinol, fifty-three showed growth on incubation. This was slightly more than 32 per cent. The antiseptic power of the small amount of hexylresorcinol present may represent the difference between the 55 per cent of the patients who had not been given hexylresorcinol and the 32 per cent of those who had received it.

The observation in three cases of meningococcic meningitis, two cases of pneumococcic meningitis and five cases of abscess of the brain failed to reveal the slightest improvement under treatment with hexylresorcinol. When one observes neurosurgical cases complicated by postoperative infection, one evidently

3. Elliott, D. C., and Barbour, H. G.: A Sensitive Test for Hexylresorcinol in Body Fluids and Notes on Its Application, Canad. M. A. J. **15**:787 (Aug.) 1925.

sees some slight influence in retarding the course of the infection. This is especially true in cerebrospinal leak. The cases observed, however, are far too few to be of great significance.

Hexylresorcinol was then introduced into normal cerebrospinal fluid which had been incubated for forty-eight hours to eliminate the possibility of contamination. Sufficient hexylresorcinol was then introduced to produce a concentration of 0.015 per cent. I believe that this concentration exceeds that found in the cerebrospinal fluid of persons receiving the drugs in adequate dosage. To 10 cc. amounts of such fluid, varying amounts of twenty-four hour broth cultures of colon bacilli, streptococci and staphylococci were added, and the tubes were then reincubated. The results are indicated in the accompanying table.

Results of Tests of Spinal Fluids

Quantity of Spinal Fluid, Cc.	Quantity of 24 Hour Broth Culture, Cc.	Number of Specimens Showing Growth	Number of Negative Specimens
	B. Coli Communis		
10	0.1	4	0
10	0.2	4	0
10	0.3	4	0
10	0.4	5	0
10	0.5	3	0
10	0.6	3	2
	Streptococcus Pyogenes Holman		
10	0.1	5	0
10	0.2	5	0
10	0.3	5	0
10	0.4	5	0
10	0.5	4	1
10	0.6	3	2
	Staphylococcus Aureus Hemolyticus		
10	0.1	5	0
10	0.2	5	0
10	0.3	5	0
10	0.4	2	3
10	0.5	4	1
10	0.6	3	2

CONCLUSIONS

1. Hexylresorcinol is probably eliminated in small amounts in the cerebrospinal fluid when administered by mouth.

2. The drug is not obtained in appreciable amounts in the cerebrospinal fluid when administered by mouth for less than five days or in doses of less than 15 grains daily.

3. The concentration of the drug in the cerebrospinal fluid under these conditions is less than 0.015 per cent and is not sufficient to indicate a reduction of surface tension, such as occurs when the drug is eliminated in the urine.

4. Hexylresorcinol is not of practical value in a frank suppurative meningitis.

5. As a prophylactic in neurosurgery, hexylresorcinol may possess slight but doubtful value.

News and Comment

POSTGRADUATE COURSE IN NEUROPSYCHIATRY

A systematic course in neuropsychiatry and related topics will be given at the Vienna University between Jan. 2 and Feb. 28, 1928. The course, given under the auspices of the American Medical Association of Vienna, will be in English and will be participated in by professors Wagner von Jauregg and Marburg, with a distinguished corps of assistants. The fee for the course is $214. Applications should be sent to Dr. E. Spiegel, Falkestrasse 3, Vienna, I. The minimum number of students for whom the class will be held is eight and the maximum, fifteen.

NEW JOURNAL OF PSYCHOANALYSIS

The first French periodical dealing with psychoanalysis has just appeared under the title of *Revue de psychanalyse*. The editors are Drs. A. Hesnard, Toulon; Laforgue, Paris; C. Odier and R. de Saussure, Geneva, with Miss Marie Bonaparte. The periodical is published quarterly by Gaston Doin et Cie, Paris.

Abstracts from Current Literature

CLINICAL INVESTIGATIONS OF THE ETIOLOGY OF SYRINGOMYELIA—THE "STATUS DYSRAPHICUS." FRIEDRICH WILHELM BREMER, Deutsche Ztschr. f. Nervenh. **95**:1 (Dec.) 1926.

Bremer discusses the etiology of syringomyelia on the basis of the work of Henneberg and of Bielschowsky. Syringomyelia affects mainly the spinal cord and causes manifold symptoms. According to Schlesinger, it affects men twice as frequently as women, and is more common in middle age. Many conditions have been suspected as possible causes: leprosy, syphilis and alcoholism. Minor, Kölpin and Westphal, Jr., consider trauma a possible cause, and Nonne reports a case of apparently traumatic origin. F. Schultze expresses the opinion that the "gliosis," at least in some cases, may be the result of natal traumatism. Heredity has long been suspected as a factor.

Schlesinger (1902) advised caution in deciding that cases were hereditary, but recognized two observations (Nalbandoff and Preobrajenski) as entitled clinically to this distinction. He pointed especially to the lack of anatomopathologic data. Schlesinger, however, thinks that "predisposed conditions," "with anomalies" during the formative period of the medullary groove must have some relation to the disease. Since then, cases have appeared in the literature which cast doubt on the familial nature of the disease.

Krafft-Ebing (1892), and Ferranini, Verhogen and Vandervelde (1894) reported the first cases of hereditary syringomyelia. In 1899, Preobrajenski reported cases in a family in which the father, aged 65, and two daughters, aged 18 and 32, suffered from syringomyelia. One of the patients also showed some acromegalic symptoms. About the same time, Nalbandoff reported syringomyelia in a mother and son. Clark and Groves (1909) reported the disease in two sisters, with a circular limitation of sensory disturbance around the legs. Goldbladt (1910), Krukowski (1913), Price (1913) and Karplus (1915) reported similar cases. Redlich (1916) reported syringomyelia in two brothers with typical symptoms. Sindler (1920) found syringomyelia in two brothers. Wexberg (1922) found the disease in a father and son. Barré and Reys reported the cases of a brother and sister. In all these cases the symptoms were more or less outspoken.

Other cases reported in the literature, while not typical, show symptom-complexes which approximate that of syringomyelia. Among the symptoms may be mentioned marked trophic changes, mostly in the lower extremities. Bruns (1903) reported a family in which four of five sisters and brothers suffered from symmetrical gangrene of the feet. Later there developed muscular atrophy, fibrillary twitching, loss of the deep and skin reflexes in the lower extremities, and dissociated disturbance of sensibility either partial or complete. Ruteford, Halliday and Whiting (1909) reported cases in a family in which four generations showed marked trophic disturbances in the hands and feet, with atrophy in the interossei and peronei and loss of knee jerks. The disturbance of sensibility was not definite. Göbell and Range (1914) reported twelve cases of symmetrical gangrene of the feet of young male members of a family; six of the patients died. There was disturbance of all qualities of sensibility, and the deep reflexes were partly lost. It is not difficult to differentiate typical Raynaud's disease from typical syringomyelia, but there is a group of borderline cases in which the symptoms of the two shade off

into one another. This does not indicate that the etiology of the two is the same. In reporting the cases the authors are cautious in making a diagnosis. Under the name "acroasphyxia chronica" Cassirer has described cases of gradual onset of local asphyxia with trophic and sensory disturbances but without pain. The trophic disturbance was manifested in hypertrophy either as "acroasphyxia hypertrophica" (resembling the main succulente of syringomyelia) or as "acroasphyxia atrophica." There is often diminished sensibility to pain and cold, especially in the vasomotor area.

Finzi studied twenty-one cases of syringomyelia and found general bodily disturbances and hereditary taint. There was disproportion between the size of the trunk and of the limbs, especially between body length and extension length of the arms (Spannweite), which is said to be due to increase in size of the extremities in syringomyelia, a fact noted by former observers. Finzi also found other anomalies: asymmetry of the face and ears, high palate, different shades in the hair of head and beard, scanty hair in the axilla, a high diaphragm, differences in the size of the blood vessels on the two sides of the body, congenital narrowing of the blood vessels, early rigidity, eccentric pupils, enlarged tonsils, large lymph nodes and enlarged spleen. These facts raise the question of a constitutional factor in syringomyelia.

Others have pointed out constitutional anomalies in syringomyelia. Henneberg noted the combination with spina bifida, and such cases have been found in the fetus and in the new-born by many observers. Tumors of the spinal cord have also been found in association with syringomyelia. This condition is often combined with other diseases of the nervous system, such as tabes, epilepsy, multiple sclerosis and acromegaly. Marburg reported a case in which the patient had a cervical rib.

Bielschowsky comes to the conclusion that syringomyelia is a congenital condition in which the central canal of the cord fails to close during fetal life. According to him, the central canal does not close uniformly; the ependymal cells of the posterior segment normally grow toward the ventral area leaving a small space at the ventral area of the canal. In syringomyelia, this closure is not well accomplished and leaves a cavity. At the same time the glia cells proliferate to fill in the space, developing a gliosis which later may break down to form a secondary cavity. Syringomyelia therefore is primarily congenital and may grow worse from secondary influences or may exist throughout life without causing symptoms. Trauma may indirectly cause breaking down of the gliosis, and thus give rise to the symptoms. Bielschowsky thinks the faulty closing of the canal may be due to the ingrowth of blood vessels into the cord carrying with them connective tissue which interferes with proper development of the cord. Henneberg, too, considers syringomyelia congenital, and proposes the names "status dysraphicus." Bielschowsky says: "From the anatomic facts one is justified in calling the attention of clinicians to the hereditary physical degeneration stigmas in this disease . . . with further increase of our knowledge in this field we may acquire valuable diagnostic insight even for cases in which the symptoms have not reached mature development."

Bremer reports four groups of cases. In the first group are ten cases of syringomyelia. Many members of the families were examined with the object not only of trying to establish a common symptomatology, but also of detecting a familial hereditary factor. From the studies of these ten families Bremer concludes that the important symptoms are: (1) Anomalies of the sternum which may be flattened, funnel shaped or gutter-like. Pierre Marie and Astié

have stressed this point. This condition was found frequently either in the patients themselves or in some members of their families. (2) Kyphoscoliosis, which was found in nearly all the families of the patients. (3) A difference in the size of the breasts. (4) Increase in the extension length (span distance) over the ordinary body length. The kyphoscoliosis must be held responsible for this to a certain extent, but the fact cannot be overlooked that many patients as well as some members of their families had unusually long hands. Long arms must therefore be classed as one anomaly in syringomyelia. (5) Livid and cold hands. Acrocyanosis was found frequently in the patients and in members of their families. This fact has been noted by many observers. (6) Curved, disfigured fingers. (7) Circumscribed, circular sensory disturbance. (8) Enuresis, which some authors think is due, at least in some cases, to spina bifida occulta. The fact that some members of the families with enuresis were shown by roentgen-ray examination to have spina bifida would tend to substantiate such assertions. (9) Stigmas of degeneracy: a high roofed mouth, anomalies of the hair and ears, a high diaphragm, status lymphaticus, and other signs.

In the second group Bremer reports ten cases. Some patients showed more pronounced symptoms than others. In the second patient, a roentgenogram showed a spina bifida occulta. The diagnosis of syringomyelia might be questioned in some of the cases in this group. For example, in case 6, the symptoms were only a funnel-shaped chest, dorsal scoliosis and increased knee and achilles jerks on the left. Bremer, however, considers this an early case of syringomyelia.

In the third group Bremer reports the cases of two patients and of some members of their families. In case 1, a girl, aged 18, developed pain in the back after sudden movement. It was followed at once by paralysis of both legs with incontinence of urine and feces. The paralysis was flaccid in the legs with pyramidal disturbances of the upper extremities and a Horner's syndrome on the right. From the seventh dorsal segment downward there was complete loss of pain and temperature sensibility. In this case a minimal trauma was responsible for the hematomyelia in a patient with evidences of syringomyelia. Two other members in this family showed unmistakable symptoms of syringomyelia.

In the fourth group, Bremer reports nine cases of the borderline type. The symptoms were not marked. In the first patient, for example, the only symptoms were cold livid hands, kyphoscoliosis and depressed sternum. In spite of this Bremer considers them early or not fully developed cases of syringomyelia.

Bremer's work is timely, and his observations tend to show an hereditary constitutional predisposition in syringomyelia. The anomalies noted by Bremer, especially in those cases which may be called early or not fully developed, should be regarded as stigmas of degeneracy or of malformation, which more study may prove to have a more or less common basis.

BERNIS, Rochester, N. Y.

NERVOUS DISORDERS IN CERTAIN TROPICAL DISEASES. A. AUSTREGESILO, Rev. neurol. **1**:1, 1927.

The author considers trypanosomiasis (Chagas fever), malaria, beriberi, ankylostomiasis, leprosy, ainhum, bubonic plague and yellow fever from a neurologic point of view.

Chagas fever or endemic trypanosomiasis in the acute stage gives rise to a rather marked febrile illness with rapidly progressing myxedema, enlargement

of the spleen, liver and lymph nodes. After a few days, nervous phenomena appear, consisting of headache, projectile vomiting and either maniacal excitement or profound stupor. Contractures develop, especially in the muscles of the neck, and there are positive signs of Kernig and Brudzinski. Cutaneous hyperesthesia is marked and "tâche cérébrale" is frequent. Convulsions usually conclude the acute stage. The acute form is particularly frequent in infancy. Adults exhibit chronic nervous disorders consisting of various syndromes, among which cerebral diplegias are the most common. Dysarthria or dysphagia, crises of chorea with spasmodic laughing and mental disorders often occur. The expression is typical, suggesting dementia, and saliva runs from the mouth. The voice is monotonous. The tendon reflexes are exaggerated. A pseudobulbar syndrome is manifested almost exclusively by muscular hypertonia. Convulsions are frequent, usually jacksonian in character. Involuntary movements such as athetosis, sometimes dominate the picture. Occasional cases of cerebellar type are recognized. Mental deterioration may run from mild hebetude to complete dementia.

Schizotrypanum cruzi, the etiologic agent, is found easily in the circulating blood during the acute stages and by the inoculation of guinea-pigs with blood or lymph during the chronic stage. Complement fixation is usually positive. Examination of the cerebrospinal fluid yields negative results. In the acute form there are nests of trypanosomes in the brain with foci of encephalitis and myelitis. The neuroglia seems to be the element especially attacked. *S. cruzi* is not found in the meninges. Experimental trypanosomiasis gives the same pathologic picture.

The treatment is symptomatic, as no specific agent has been discovered comparable to that so well described in African trypanosomiasis.

Malaria gives rise to nervous phenomena, usually in the estivo-autumnal form. According to Fonseca, any number of nervous forms may occur, thirty being mentioned by name, ranging from polioencephalitic to a Raynaud type. The symptoms are probably aroused by parasitic or pigmentary emboli in the small blood vessels, together with the malaria toxins. Coma is the form most frequently seen, and differs little from coma of other cause, the differentiation being made by examination of the blood. A meningeal reaction is sometimes noted, particularly in infants; convulsions are noted under the same circumstances. Paralysis may be of cortical, capsular or extrapyramidal type, usually coming on during an acute febrile episode, and it is usually transitory. The cranial nerves are occasionally affected, and speech is sometimes disturbed. Cerebellar disorders are particularly interesting and tend to clear up. Paludal polyneuritis is not frequent and is usually confused with beriberi. To avoid these nervous disorders treatment must be prompt, intensive and prolonged; the results are often brilliant.

Beriberi occurs in epidemics and also endemically, particularly in hospitals, barracks and prisons. The cause is still not definitely decided, but polyneuritis is manifested early, and progresses rapidly within a few days. Paresthesias, neuralgias and paralyses are obvious, and visceral disorders are also characteristic — the most important probably dealing with circulation. In mild cases there is tachycardia, palpitation, extrasystole and precordial distress, whereas in the severe cases gallop rhythm, paradoxic pulse and functional murmurs are frequent. Anasarca completes the syndrome of cardiac insufficiency, particularly of the right ventricle. Paralyses of the smooth muscles give rise to pulmonary congestion and dyspnea, whereas flatulence and constipation or diarrhea betray involvement of the digestive system. "The clinical evolution

of beriberi is as a rule tumultuous. All the phenomena come on rapidly, sometimes accompanied by fever and always with a strong tendency to acute or superacute evolution." The acute forms sometimes decimated armies. The etiology is now considered to be in the realm of vitamins. The prognosis is rather serious in sporadic cases and grave during epidemics. The paralytic form is a less serious menace to life. Relapses are bad; yet some patients unexpectedly get well or die. Treatment consists in bleeding, with blood transfusion and stimulants, but particular emphasis is laid on substances rich in vitamins. Change in climate and physiotherapy, especially thalassotherapy, are excellent auxiliaries.

Nervous disorders in *ankylostomiasis* are usually of the mental type, giving rise to confusion, hypochondria and stupidity. Occasionally mental infantilism is observed, and possibly this is due to hypothyroidism. Psychoneuroses and neurotic syndromes, as well as hysteria and neurasthenia, are frequently observed. The somatic delusions almost always concern the abdomen and the heart. In cases of parasitosis of this type, the patellar reflexes are frequently exaggerated. Occasionally primary polyneuritis is observed, characterized by the usual set of symptoms: sleepiness, edema, exaggeration of reflexes and pains in the limbs. In advanced cases with cachexia, meningeal symptoms are observed, delirium, convulsions, paralysis and coma. Edema may develop suddenly and bring about serious, or even fatal, apoplectiform attacks. Nervous and mental disorders in ankylostomiasis, however, are not particularly frequent. Pathogenesis is by direct intoxication and by pernicious anemia.

Leprosy as observed in South America is characterized by the involvement of the most peripheral portions of the nerve with later advance in a centripetal direction. The lepra cells are localized in the interfascicular connective tissue. They spread the fibers apart, compress the myelin and finally cut the axis cylinders. The diameter of the nerve is usually increased, and calcareous deposits with pigmentation are not rare. Diagnosis is easily made by finding the bacilli of Hansen. Among the clinical forms, leprosy attacking several peripheral nerves more or less localized, but seldom limited to one nerve, and equally seldom attacking all the nerves, is most frequent. More rarely the roots are invaded, and cerebral involvements are distinctly unusual. Painful phenomena sometimes occur with extreme violence, and may be confused with the lightning pains of tabes. At other times, they are less striking. Cutaneous hyperesthesia likewise is observed, and the nerves are sensitive to pressure. Anesthesia follows this stage of hyperesthesia, and the superficial sensibility is rapidly lost in the discolored plaques. The anesthesia may be elective, thermic sensation disappearing first, then tactile, then pain. Occasionally syringomyelic dissociation is observed. Finally, atrophies, paralyses and deformities develop. The tendon reflexes are lost. The ulnar, sciatic and trigeminal nerves are the most frequently affected.

Ainhum belongs to the pure African negro and his descendants, and is characterized by itching in the interdigital space with the formation of a constricting band and spontaneous amputation, usually of the little toe. Its course is usually chronic. Other lesions than these trophic ones apparently do not occur.

Bubonic blague manifests no especial nervous disorder, but commonly psychic disturbances. Meningitis is sometimes observed, as well as cerebral edema and meningeal hemorrhage. Otherwise the nervous symptoms of bubonic plague are those common to other infections. The same is true of *yellow fever* although in this disease hemorrhages may affect various parts of the brain, giving

rise to convulsions, coma, dysarthria and paralysis. "If the patients recover from such a malignant infection, the organs recover with relative rapidity. It is an honor and good fortune for us that so serious a disease no longer exists in Brazil."

FREEMAN, Washington, D. C.

CHANGES IN THE CEREBRAL CORTEX OF GENERAL PARALYTIC AND SYPHILITIC PATIENTS TREATED BY MALARIA. J. NAKAMURA, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **28**:197 (May) 1926.

There are two schools of thought regarding the effect of malarial treatment on the anatomic picture in general paralysis. The followers of one, represented by Sträussler and Koskinas, maintain that malarial treatment not only increases the inflammatory reaction in the brain but also changes the character of the process—a malignant inflammation becomes partly replaced by a specific benign form of granuloma. This view is also held by Gerstmann and by Löwenberg. The members of the other school, represented by Bielschowsky, Spielmeyer and Foerster, deny any anatomic change following malarial therapy.

Before describing his own cases, the author calls attention to the fact that Sträussler and Koskinas' patients—with remitting general paralysis—all showed remissions following malarial treatment.

Following is a resumé of Nakamura's cases:

CASE 1.—A woman, aged 55, who died three days after the first malarial paroxysm, showed no pathologic changes (only the cord was available for examination) that could in any way be interpreted as inflammatory or acute. Except for a marked hyperemia, the cord showed the changes usually observed in a paralytic cord with tabiform changes. The only striking feature was that the tigroid substance in some motor cells did not show the usual destruction, the granules only having disappeared.

CASE 2.—A woman, aged 58, with a condition diagnosed as the tabetic type of general paralysis, died from pneumonia after the first febrile paroxysm. Only the brain was examined. It showed the typical picture of general paralysis, although the tissues contained more cells than the vessels; the cells were full of malarial pigment, more at the periphery than in the center. The tissues showed a definite formation of nodules; these, however, were small and seemed to consist solely of glia cells. Large masses of diplostreptococci were also found in the tissues. The vessels, which contained pigment cells, were unusually rich in exudate and leukocytes. It was also noteworthy that the sections showed some vessels full of exudate alongside of others without exudate.

CASE 3.—A woman, aged 65, with tabes developed a psychosis—nonparalytic. Following one malarial injection she had three febrile paroxysms, and four days after the last paroxysm, just as she was about to have another, died. The cortex showed no evidences of general paralysis although the vessels contained many pigment-containing cells. Plasmodia were found within and without the vessels. Here, too, the tissues showed a definite neuronophagia and nodular formation (malarial nodules) which in some parts of the brain was close to the vessels and in other parts remote from them.

CASE 4.—A man, aged 40, with general paralysis died of emaciation and general exhaustion two days after his seventh malarial paroxysm. Here the paralytic process was unusually well marked and seemed to involve the entire brain; it involved parenchyma, blood vessels and meninges. In the tissues were numerous pigment-containing cells the form, size and structure of which resembled plasma cells. The pigment was found evenly distributed throughout the entire

brain, pia and vessels. The vessel walls were studded with spindle and sausage-shaped metachromatic cells of rather peculiar structure not unlike that observed in plasma cells. Some sections showed intense lymphoid infiltration and neuronophagia.

Case 5.—A man, aged 62, with tabes and slight evidences of dementia, died after the fourth febrile paroxysm following malarial inoculation. The cerebral cortex showed marked meningeal fibrosis which seemed to have been more acute over the temporal region. The vessels in this part of the brain were surrounded by an extensive inflammatory process, some being completely surrounded by lymphoid cells; they also showed evidences of severe sclerosis and differed from the vessels in case 4 in that, within the intense perivascular glial proliferation, there were also areas of beginning disintegration. The pigment in the tissues in this case was rather scanty in amount. Some sections showed numerous plasmodia.

Case 6.—A man, aged 54, was twice unsuccessfully inoculated with malaria; he died in a confused state seventy-five days after the second injection. The clinical picture was that of general paralysis, although the cerebrospinal fluid was not typical of that disease. Macroscopically, the brain was normal; microscopically, the predominating lesions were found in the vessels; these were not inflammatory but corresponded to the changes described by Nissl and Alzheimer in syphilis of the small cerebral vessels; the pia showed a chronic fibrous productive inflammation, and the vessels an unusually severe reactive gliosis. Only here and there could one see an increase in the glia cells. Some of the cells of the adventitia showed pigment which Nakamura thinks is normal, and not due to the unsuccessful malarial inoculations. Strikingly, the process involved only the more delicate nerve fibers but not the ganglion cells. Some areas showed extensive perivascular disintegration. The tissues also showed a marked reaction in which the glia cells were found grouped in small masses. Neuronophagia was present, and all parts of the brain showed a great number of red cells. The process in the parenchyma as well as in the meninges was more intense in the frontoparietal than in the occipitotemporal region.

Three of the author's patients were definitely paralytic; two, although presenting neurologic as well as mental symptoms of paralysis, proved anatomically to be tabetic; in these the meningeal changes were marked. At necropsy one patient, clinically paralytic, showed only syphilis of the smaller cerebral vessels. A survey of this material, scanty as it is, shows, according to Nakamura, that the effect of malarial treatment consists in an increase of nuclei in the parenchyma; this applies to the paralytic as well as to the nonparalytic patients. One apparently deals here with an increase in the glial nuclei which may go on to the formation of nodules, although the latter never seem to be excessive. Taking into consideration the additional fact that the brains in all the patients treated by malaria showed typical malarial pigment, and that in some of them the *Plasmodium malariae* could be found, one must explain the reaction in the parenchyma as an expression of the malarial infection. The "malarial process," nevertheless, does seem to affect the paralytic exudate in two ways: (1) some parts of the brain show a predominance of lymphoid cells; (2) occasionally the plasma cells assume a peculiar "mast-like" appearance. It would seem then that the paralytic exudate does undergo some alterations. In this change two features must be emphasized: (1) the effect of the malarial inoculation on the tissue itself in the nature of a proliferation of glia, and (2) a possible transformation of the paralytic exudate itself. (The author is apparently not absolutely certain as to the truth of the second feature.) Nakamura is at a loss to explain how

these changes come about, but he is positive that the changes induced by the malaria are slight and readily curable. Before closing he also points out that the change in the exudate induced by malarial inoculation does not occur in every part of the brain to the same extent, but is rather limited and more evident in some parts than in others. The change apparently does not become generalized until a remission has set in; as to this, however, he is not at all positive and does not care to pass final judgment on this phase of the problem.

KESCHNER, New York.

THE BLOOD AND SPINAL FLUID IN CASES OF TREATED AND UNTREATED PATIENTS WITH GENERAL PARALYSIS. F. WALTHER and S. ABELIN, Archiv für Psychiat. u. Nervenk. **78**:281, 1926.

Walther and Abelin report the results of a series of serologic investigations in thirty-two cases of general paralysis. Seventeen patients were untreated up to the conclusion of the present investigation. Thirteen of the other fifteen were treated with malaria, one with silver arsphenamine and one with bismuth emetine iodide (the last one belonging to a series of cases previously reported). The reactions studied were as follows: Wassermann and Sachs-Georgi test of the blood, cell count, Wassermann, Nonne-Apelt, benzoin and Weil-Kafka hemolysin reactions in the cerebrospinal fluid. The frequency of positive reactions in cases diagnosed as general paralysis, their behavior during the course of untreated paralysis, and the influence of different anti-syphilitic measures on them, formed the basis of the investigation. The results can be best presented in the following summary:

1. The Blood Wassermann Reaction: There was a positive reaction to the first test in 90 per cent of the cases. Repeated tests in untreated paralysis showed that a positive Wassermann reaction is to be obtained at some time or other in 100 per cent of cases. It may fluctuate, however, and in atypical cases is liable to remain negative for some time. Silver arsphenamine and bismuth emetine iodide influence the intensity of the reaction and may even, at times, bring about a temporary negative reaction. Treatment with malaria causes, as a rule, an increase in intensity at first, then a decrease, in some cases resulting in a negative, but there is always a recurrence of the positive reaction.

2. The Sachs-Georgi Reaction in the Blood: The reaction is positive with the first test in 80 per cent of the cases and shows a fluctuation from strongly positive to negative reaction in untreated patients. Treatment with malaria may cause no change at all, or an increase immediately after conclusion of treatment, and then different forms of fluctuation. There seems to be no particular relation between the behavior of this and the blood Wassermann reaction at different periods of the disease. Similarly, there is no definite relation between the degree of intensity of these reactions and the clinical picture.

3. The Cerebrospinal Fluid Wassermann Reaction: In 90 per cent of the cases the reaction is positive to the first test. In the course of untreated cases it generally remains positive, but may show fluctuations and may even disappear temporarily. Silver arsphenamine may cause decrease in intensity and even a temporary disappearance of the reaction. Treatment with malaria causes increase in intensity immediately after it is concluded, followed by marked decrease and, at times, disappearance of reaction. In the experience of the authors a permanently negative Wassermann reaction was never obtained.

The Wassermann reaction is positive in the blood and the cerebrospinal fluid in 87.5 per cent, is positive in either one or the other in 100 per cent, and is negative in either one or the other only in atypical cases. The fluctuations during the course of the disease are more marked in the blood, but the two generally run parallel to one another.

4. The Cell Count: Ninety-six per cent of the cases show pleocytosis (more than 5 cells) in all first cell counts. The number of cells is generally between 30 and 50. Chronic benign cases show less; a cell count of 100 and over generally means a complicating cerebral syphilis. In the course of untreated cases one finds marked fluctuations in the cell count (mostly in acute cases). The pleocytosis is much influenced by treatment. Potassium iodide, silver arsphenamine, and similar drugs, cause decrease, sometimes even down to normal. Treatment with malaria changes the cell count at the beginning, causing a decrease, and, in many cases, a normal cell count. The probabilities are that the treatment with malaria is most effectual in arresting the meningeal proceses and, like other antisyphilitic measures, least effectual in the parenchymatous processes.

5. The Nonne-Apelt Globulin Reaction: The reaction is positive in 96 per cent of the cases. In untreated patients there seems to be a direct relation between the intensity of this reaction and the malignancy and acute course of the disease. It shows slight fluctuations during the course of the disease. Silver arsphenamine and bismuth emetine iodide do not influence this reaction much. Treatment with malaria has the same influence on this reaction as it has on the Wassermann reaction; the fluctuations, however, are not as marked.

In general, it seems that this reaction is much more stable and dependable than either the Wassermann reaction or the cell count. It shows less fluctuation, and, although its course is somewhat similar to that of the Wassermann reaction, it shows no parallelism to the cell count.

6. The Benzoin Reaction: The reaction is positive in 100 per cent of cases, and shows no appreciable changes either during the course in untreated patients or during treatment.

7. The Hemolysin Reaction: The reaction is positive in 67 per cent of cases. In the course of untreated general paralysis it is negative, or faintly positive, in the benign chronic forms, and is more intensely positive and more permanent in the acute and malignant cases. During treatment with malaria there seems to be a sudden and permanent disappearance of the reaction in a large percentage of cases; others show more or less marked fluctuation. This reaction seems to show no definite relation to any of the other reactions.

On the whole, the serologic changes, within broad limits, run parallel to the clinical picture in cases of untreated general paralysis, the fluctuations of the clinical picture coinciding more or less with those in the intensity of the serologic reactions, and can be of some prognostic value. Frequently, however, they run independently and bear no relation to one another. The influence of antisyphilitic therapy on the serologic changes is not consistent enough to be of any value in prognosis. The most marked changes are found in the cell counts and generally in reactions that are based on the meningeal processes. The Wassermann reaction is less influenced, and least of all are the reactions dependent on the globulin content. Serologic investigations of large quantities of cerebrospinal fluid show that there is no marked difference between the first and last portions of the fluid withdrawn. The only constant difference is that in cell count, but it is slight.

MALAMUD, Foxborough, Mass.

RECENT ADVANCES IN PERNICIOUS ANEMIA. Editorial, J. A. M. A. **89**:793 (Sept. 3) 1927.

The Journal of the American Medical Association (**87**:249 [July 24] 1926) referred to an address delivered in this country by Knud Faber (*Am. Clin. Med.* **4**:788 [April] 1926), in which the well known Danish clinician reaffirmed that pernicious anemia may be caused by intestinal intoxication, that achylia gastrica favors this process, and that the source of the toxic material is elsewhere than in the intestine when pernicious anemia develops in the course of an acute septic disease. Whatever the cause, if protracted hemolysis supervenes, the hematogenic organs become exhausted. Wells ventured the suggestion that this exhaustion may be enhanced by toxic substances in the blood. Knowledge of the important work of Whipple and Robscheit-Robbins (*Am. J. Physiol.* **72**:408 [May] 1925, cited by Minot and Murphy), Gibson and Howard (*Arch. Int. Med.* **32**:1 [July] 1923), and others (References are given by Minot, G. R., and Murphy, W. P.: *J. A. M. A.* **87**:470 [Aug. 14] 1926), seems to have been lost to the general medical reader along with other material on dietotherapy of anemia. *The Journal* comment, therefore, substantially summarized the general knowledge of pernicious anemia up to the time of publication.

Less than a month later *The Journal,* published an article by Minot and Murphy in which they related their results with forty-five patients suffering from pernicious anemia and to whom they had administered "a diet composed especially of foods rich in complete proteins and iron—particularly liver—and containing an abundance of fruits and fresh vegetables and relatively low in fat." Improvement was prompt and rapid, but they felt that enough time had not elapsed to justify full confidence in the treatment. In the same issue was printed a paper by Koessler, Maurer and Loughlin (*J. A. M. A.* **87**:476 [Aug. 14] 1926). These authors believed that in some cases, at least, the phenomena accompanying pernicious anemia are the result of long continued deficiency in vitamin A and possibly also in vitamins B and C. The deficiency may arise from underfeeding or from insufficient utilization. The results obtained enabled these investigators to conclude, "The routine use of a rationally balanced diet which has proved itself thus far of decided value in the blood regeneration of patients suffering from severe anemias, aplastic as well as erythroblastic, is the most promising procedure in the treatment of certain anemias, especially pernicious anemia." Koessler and his associates thought, however—as Minot and his colleagues had considered of their own efforts—that insufficient time had elapsed to pass final judgment on their procedure. In the spring of the next year, Murphy, Monroe and Fitz (*J. A. M. A.* **88**:1211 [April 16] 1927) reported the blood changes obtained under the Minot and Murphy regimen, and were able to corroborate the improvement reported by these authors.

Persual of the papers by Minot and Murphy (*J. A. M. A.* **89**:759 [Sept. 3] 1927) and by Koessler and Maurer (*J. A. M. A.* **89**:768 [Sept. 3] 1926) which appear in this issue, shows that, in the main, these two authorities are in considerable agreement regarding the means they would employ to combat pernicious anemia. Each would prescribe an adequate general diet, including a large quantity of liver and kidney. The principal difference with respect to diet is that Minot and his co-workers would reduce the fats, whereas Koessler and his associates declare that "butter, cream, milk and cod liver oil are supreme sources of fat soluble vitamins and should be partaken of in large amounts." In this view of the vitamins lies the essential difference in standpoint of the two groups of investigators. Minot and Murphy have shown that a nonprotein fraction of liver pro-

duces benefit in pernicious anemia and that this fraction is apparently not one of the known vitamins. Koessler, on the other hand, although he credits the discoveries of Minot and Murphy, is convinced that any treatment ultimately will be ineffective which does not provide for a copious supply of vitamins in the diet. Work by Macht (*J. A. M. A.* **89**:753 [Sept. 3] 1927) ingeniously demonstrates that the blood serum of patients with pernicious anemia contains a toxin, and that this blood serum can be detoxified by irradiation with ultraviolet rays. Furthermore, he found that the effect of ultraviolet rays could be increased by introducing into the serum to be treated various dyes which act as sensitizers. This was tried not only in vitro but also in vivo, with encouraging results. These discoveries suggested to Macht yet another explanation of the benefit derived from the liver diet; namely, that since the liver is a storehouse for blood pigments, "some of these pigments may help increase the effectiveness of light in this disease."

The immediate future has much to offer with regard to the etiology and treatment of pernicious anemia. The developments of present importance are that methods of combating the disease have been devised which have given results so encouraging that men of recognized scientific and clinical judgment are advocating them: (1) liver diet, (2) feeding of foods of high vitamin content, and (3) ultraviolet irradiation with or without the adjuvant use of sensitizing dyes.

THE METABOLISM IN OBESITY. Current Comment, J. A. M. A. **89**:795 (Sept. 3) 1926.

Interest in the problem of obesity has become accentuated in the last few years through the circumstance that overweight is deprecated from esthetic standpoints as well as through consideration of its undesirability on the basis of the outlook of good health. There is no doubt that obesity is frequently the result of overnutrition, particularly when this is combined with lack of muscular exercise. This simple hypothesis of a favorable balance of food intake over energy output is not convincing, however, as a universal explanation. At any rate, it does not make clear why some persons fail to gain despite all efforts to increase their food consumption, and why some seem to gain despite an apparently moderate regimen. Furthermore, in many instances obesity seems to have an hereditary background as though there were a constitutional predisposition as well as the consequence of liberality in diet. Indeed, a distinction is sometimes drawn between so-called exogenous obesity—attributed to inactivity and overfeeding—and an endogenous or constitutional type for which a variety of physiologic or pathologic functions have been held responsible (Graefe: *Ergebn. d. Physiol.* **21**:197, 282, 1923). A group of Chicago investigators (Wang, Strouse and Saunders: *Arch. Int. Med.* **36**:397 [Sept.] 1925) at the Michael Reese Hospital have expressed the belief, on the basis of careful measurements of the respiratory metabolism that the combustion of the nutrients is altered in many of the obese. Thus they have found a greater rise in the respiratory quotient of the latter than in normal persons after meals, and hence conclude that less fat is burned in the corpulent organism. Hagedorn (*Arch. Int. Med.* **40**:30 [July] 1927) and his associates in Copenhagen have verified these metabolic observations. However, they insist that the rise in the respiratory quotient is what was to be expected when a transformation of carbohydrate into fat takes place to a greater extent than in persons of normal weight. The Danish clinicians therefore defend the hypothesis that obesity is due to a qualitative anomaly in metabolism; that is, an abnormally increased transformation of carbohydrate into fat.

CHAMBERS, Syracuse, N. Y.

CEREBRAL EDEMA IN TUMORS OF THE BRAIN. IKUTARO TAKAGI, Arb. a. d. Neurol. Inst. a. d. Wien. Univ. **28**:60 (May) 1926.

In a patient, aged 44, with an endothelioma of the right frontal pole, necropsy revealed a considerable increase in the size of the left cerebral hemisphere, whereas the right side of the brain was apparently normal in size. On superficial examination, the enlarged left side did not appear edematous. This led to the following study, which was undertaken to determine, if possible, the cause of the enlargement of that hemisphere.

A sagittal section of the brain through Brodmann's area VIII, made so as to include the "tumorous" as well as the "nontumorous" side, at the same level, showed subpially on the "tumorous" side large numbers of corpora amylacea; the overlying pia appeared somewhat wider but purely fibrous in structure, and in some spaces somewhat separated from the brain, so that the superficial glial layers were clearly visible; no changes were observed in the molecular nor in any of the other deeper layers. Not until the transition between the gray cortex and the white substance was reached did the vessels show any evidences of edema; it was here that one could see areas of perivascular, blood-containing cells. It was striking that the edema was limited solely to the white matter. A section of the "tumorous" side stained by the Nissl method showed the cortex free from cell changes and no displacement of any of the cortical layers. Except for the slight edema in the center of the brain on that side, Weigert preparations showed no changes in the nerve fibers. An examination of the same area on the "tumorous" side showed a marked pial edema; the superficial glial layer was not as closely attached to the pia as on the other side, but it showed many ridge-like elevations; in the gray matter, the ground substance in the molecular zone was not dense but formed a fine network of small interspaces; this network was perivascular and extended deeply into the cortex — however, the edema of the cortex itself was slight. Most characteristic changes were encountered in the corona radiata; here the network was more distinct and coarser, with many perivascular dilatations leading to disintegration, and in some areas it contained cells with blood pigment. The Nissl stain showed clearly that the cortex was not severely damaged; its cells showed an abundance of tigroid material, and the gray cortex was not particularly rich in glial elements; the cellular prolongations of lamina II were horizontal and not vertical; lamina III also showed evidences of degeneration, only the ganglion cells of this layer being well preserved; the deeper layers showed considerable neuronophagia, and there was a marked increase in the nuclei of the white substance. The Weigert stain showed the tangential fiber layer less developed than on the opposite side; otherwise, there was little involvement. The fine fibril network was less dense and the corona radiata somewhat paler than on the contralateral side. The axis cylinders were not swollen.

Sections of the same area on the "nontumorous" side did not seem to take the stain as well, and the axons seemed to be less dense than those on the "tumorous" side. The sections were practically the same in other areas.

Takagi believes that these observations indicate an irritation of the meninges in the region of the tumor producing complete adhesions between the tumor mass and the meninges; this, he believes, is sufficient to produce stasis in the pia which is, however, more intense on the contralateral side. He would therefore attribute the enlargement of the "nontumorous" side to the stasis of the cerebrospinal fluid in the pia on that side. He believes that the process is analogous to that frequently observed during the war in cases of post-

traumatic abscess of the brain. It was not unusual to see a right-sided abscess of the brain with a purulent meningitis on the left side and vice versa. The fact that the meningeal adhesions, in the case reported, were more dense and extended over a greater surface on the "tumorous" than on the "nontumorous" side, which was possibly followed by a more intense reaction on the latter side, may perhaps be regarded as analogous to the contralateral meningitis observed in infected traumatic lesions of the opposite side. The severity of the general manifestations of tumor of the brain in the case reported was out of proportion to the small size of the tumor; this may possibly be reconciled with the cerebral enlargement on the contralateral side which was due to stasis. (The abstracter is not convinced that the author has proved his hypothesis).

KESCHNER, New York.

BIOLOGICAL POINT OF VIEW OF ADOLF MEYER IN PSYCHOLOGY AND PSYCHIATRY. HENRI FLOURNAY, Brit. J. M. Psychol. **6**:85 (Sept.) 1926.

The human organism is the resultant of the integrated function of its numerous parts. This organism always exists in a setting, an environment, and a study of its functions cannot be limited to an analysis of the constituent structural elements and cover only the reflexes, chemical reactions and postmortem material. A broader aim will include the behavior of the organism functioning as a unit in relation to units of its environment. Psychology is concerned with functionings of this unit, and psychiatry deals with its disorders and their treatment. The facts of behavior lend themselves to objective study to the same extent as other facts of nature. They are not understood by resorting solely to introspective methods nor are they understandable purely in terms of the physiology of the brain. These are extreme attitudes which Meyer avoids by adopting this objective approach, which is broad enough to include all facts that influence behavior.

The term psychogenetic applies to the reactions of the individual to environmental factors. The interplay of these factors leads to phenomena which cannot be understood by studying infections and postulating brain alterations. The common sense point of view considers these mental causes just as objective as the type of fact which can be studied in the chemical laboratory. It is possible to reduce the facts of nature to the elemental sciences of physics and chemistry, but doing this eliminates the important factor of integration which is characteristic of living beings. The integration of constituent parts forms a new unit just as two elements, hydrogen and oxygen, combine to form water, the properties of which are different from its two constituents. The same is true of the new biologic unit formed by the combination and integration of elements. The complexity of these vital combinations varies from purely vegetative types to units gifted with behavior and having a type of behavior which is called conscience. This psychobiologic level of activity is the highest degree of complexity. These facts of consciousness are not studied as isolated phenomena but as samples of the associative activity of the whole organism, and all are linked together by the utilization of symbols. By the utilization of signs which represent memories, perceptions, images, etc., the data of the past are related to the anticipation for the future, and the conduct of the organism is adjusted to circumstances. Symbolization gives the individual a marvelous tool for adaptation and economy.

There is no room for the principle of psychophysical parallelism in this point of view. Facts so intimately and complexly related cannot be arbitrarily divided into the two series of physical and mental. Meyer recognizes modes

of reaction in the individual and discards this arbitrary and misleading division. These reactions may occur at three levels: the vegetative, implying action of the viscera; the reflex, implying action of the nervous system, and the psychobiologic, implying the action of the complete integrated personality.

Medical psychology is primarily concerned with the functional character of the mental life, and studies behavior in the natural setting in which it occurs. In investigating these facts one must determine the particular circumstances in which the behavior occurred, analyze the influences which modified it from early childhood on and shaped the method of responding, and study the manner of meeting obstacles. In such an objective approach one determines the assets and the liabilities of the individual and knows which factor can be modifiable to bring about a better adaptation. This point of view implies that modification of behavior is possible and is not stifled by the belief in fixed constitutions. It is a practical psychology which draws its facts from the life and experiences and conduct of the individual and places the science on an objective basis that will help to overcome the psychophobia of so many in the medical world, which prevents them from using common sense in studying the behavior of a patient with a mental disease.

Meyer's point of view gives due importance to somatic factors involved in behavior disturbances. The nonmental factors of a psychobiologic reaction are all-important, however. He makes the most of the method of investigation adopted by general medicine, but recognizes that such facts can never explain a mental fact, because this requires the integrated action of the whole organism. Meyer utilizes the contributions which introspection yields and avoids the extreme of the strict behaviorists who are content with outward things alone. The content of consciousness is important, not for itself, but because of the symbolizing ability of the individual who can in this economical way reproduce the events and impressions of the past.

ALLEN, Philadelphia.

THE FORMATION OF VASCULAR AND PERIVASCULAR INCRUSTATIONS (PSEUDOCALCIFICATION) IN THE NERVOUS SYSTEM. AKIRA KAWATA, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **28**:103 (May) 1926.

The cortex of an encephalitic brain with diffuse involvement was examined. The most striking pathologic changes were infiltrations of broken down cells; these infiltrations were found in the walls of the vessels as well as in the perivascular spaces. A section from the posterior central convolution showed no such infiltrations on the surface, nor in laminas II and III; some, however, were found in lamina IV and many more in laminas V and VI; they were also found in the corona radiata, although they were not as numerous as in the deeper layers of the cortex. The histologic picture of the entire brain was that of an advanced meningo-encephalitis with hemorrhages and softenings, on the one hand, and a process of disintegration leading to malacia on the other. The numerous scavenger cells found in the perivascular spaces left no doubt as to the great destruction of the nerve parenchyma. Much of the detritus was probably derived from broken-down glia cells. The process was apparently one of coagulation in those parts in which senile plaques are usually found. This process of coagulation was unusually prominent in the neighborhood of the hemorrhages and in the areas of softening; it was just in these areas that most of the masses of detritus and incrustations were found. It must also be pointed out that these masses were found not only in the nerve parenchyma but also in the pia, in which they formed peculiar round bodies, not unlike corpora amylacea. The

location of these bodies in the innermost layers of the cortex and in the meninges speaks against their being true corpora amylacea, which are usually found in the most external layers of the cortex.

In recent years great discussion has arisen as to the mode of origin of corpora amylacea, because structures resembling them have so frequently been found in young persons, especially in encephalitis. According to Omorokow, corpora amylacea represent a breaking down of ganglion cells and their fibers, producing at first amorphous scales which later fall apart into the finest droplets and are eventually converted into a substance which assumes the well known peculiar hue with hemalum. Omorokow attributes the occurrence of these amorphous scales also in glia cells to phagocytosis. There is now a great controversy as to whether corpora amylacea represent a product of precipitation or a product of disintegration. Spiegel, for example, believes that they are both, and that some such process occurs in encephalitis. As a matter of fact, there is some reason to believe that senile plaques are also the result of a process of breaking down which later gives rise to incrustations (Oseki). A process similar to the aforementioned one is also observed in colloid degeneration. Some authors designate this condition as hyaline degeneration, others as colloidal degeneration, whereas Spatz considers it a pseudocalcification. Sträussler and Koskinas were able to demonstrate that in colloid degeneration death of tissue does not precede but follows the vascular changes, so that death of tissue could hardly be held responsible for the condition.

In the case reported in this paper there is still another factor that needs explanation. Here the principal changes are found in areas which show extensive destruction of the parenchyma, regardless of whether the latter is due to hemorrhage or to softening. The histologic preparations show clearly that the formation of the peculiar, round, more homogeneous masses was preceded by a destruction of cells, which gave rise to deep, dark droplets resembling the smallest kind of granular material. The condition then is almost analogous to that described by Omorokow in the formation of corpora amylacea. There is no doubt, however, that another process, perhaps one of precipitation, must play an additional rôle in the genesis of these bodies, because it is inconceivable how such small droplets, however numerous they may be, can give rise to so many large-sized deposits on the vessels and in the tissues. That the process is not rare is attested by the fact that Nagasaka found an analogous condition in a case of cerebrospinal syphilis, and Sträussler and Koskinas also saw a similar process in dementia paralytica.

The fact that these bodies are especially common in encephalitis would seem to point to two important factors in their genesis: (1) a destruction, predominatingly of cellular elements with precipitation, and (2) a coagulation process following inflammation.

KESCHNER, New York.

NERVE LESIONS IN EXPERIMENTAL LEAD POISONING. J. M. DE VILLAVERDE, Trav. d. lab. d. rech. biol. de l'Univ. de Madrid **24**:1 (July) 1926.

The author presents, with admirable illustrations, details of the changes observed in the peripheral nerves of young rabbits after poisoning with lead. The lead was administered subcutaneously, at a point distant from the nerves to be studied, in the form of a 1 per cent solution of the acetate. In one series of animals, 1 cc. of this solution was given daily; in a second series, the same dose was given at longer intervals, and the animals were killed earlier in order to observe the effects of more moderate degrees of poisoning. The histologic methods employed were principally the silver impregnations

of Cajal, Bielschowsky and Doinikow, and the combined Cajal-Bielschowsky glia stain, though the Nissl and Heidenhain methods were also used.

Changes were observed in the connective tissue sheath of Key and Retzius, the cells of Schwann and the axons, the two latter being the more striking. It was found difficult to demonstrate the sheath of Schwann. In the lesser degrees of poisoning, the Schwann cells underwent retraction and vacuolation of the protoplasm and loss of the chromatin network of the nucleus. The author regards these as progressive changes, though in no instance did he observe mitosis of the nucleus. With more severe and rapid poisoning, the changes were regressive; instead of becoming spongy, the protoplasm became granular, and the nucleus might not be discernible.

The axons showed remarkable changes. Many underwent fragmentation, but presented none of the characters of wallerian degeneration. Many showed a separation between the argentophil substance and the neuroplasm; the former might appear as a thin thread running through the center of a homogeneous column of neuroplasm of uniform caliber. In places there were collections of argentophil material forming irregular fibril-like threads of varying thickness that sometimes appeared to anastomose with one another, forming a meshwork which was filled up with masses of neuroplasm, sometimes of relatively enormous size. Using the terminology of Cajal, the author describes the fragments of axons as dead fibers that have been preserved *(fibres mortes et conservées)*. In a few places, abortive attempts at regeneration in the form of short processes projecting at right angles from the axon were to be seen. The author suggests that the abortiveness of the regenerative process may be due in part to the direct effect of the lead and in part to the fact that the neuron as a whole is damaged; changes of severe degree, which are not described in the article, were observed in the central nervous system. Bands of Büngner were never observed.

The principal point made is that the changes differ materially from those that follow section of a nerve, which have hitherto been accepted more or less as a paradigm of neuritic reaction. The view is taken that the circulating toxin acts first as an excitant to progressive reaction and then leads to regressive changes. In the more acutely and severely poisoned nerves the changes are more extreme and are regressive. Multiplication of the nuclei of Schwann or infiltration with mesodermal cells did not occur in any of the specimens.

LATE RESULTS IN EXPERIMENTAL NERVE POISONING BY LEAD. J. M. DE VILLAVERDE, Trav. d. lab. d. rech. biol. de l'Univ. de Madrid **24**:155 (July) 1926.

With the object of studying the possibility of restitutio ad integrum in nerves poisoned by circulating lead, the author gave 1 cc. of lead acetate solution (1 per cent) daily for several successive days and then kept the animals alive, under the best possible conditions for promoting recovery, for three and one-half months. They were then killed, and the nerves were studied as in the experiments recorded in the preceding article. The connective tissue of the sheath of Key-Retzius was definitely increased, with many free fibers. The cells of Schwann still showed marked changes in the nucleus, without the least trace of mitosis. The protoplasm was much retracted and vacuolated, especially around the nucleus. The axonal changes were similar to those described for severe intoxication in the previous article. The separation between argentophil substance and neuroplasm was still marked, and there were numerous fragmented axons, without signs of wallerian degeneration. It appears as if the axons had been killed and yet preserved from the process

of dissolution that occurs with a sectioned nerve. The author concludes that lead poisoning carried beyond a certain point results in permanent loss of the nerve fibers.

SINGER, Chicago.

GLIOMA OF THE PONS. GINICHI SATO, Arb. a. d. Neurol. Inst. a. d. Wien. Univ. **28**:38 (May) 1926.

In reviewing the literature, Sato found that in most cases of glioma of the pons the neoplasm was extremely rich in blood vessels and had a tendency to hemorrhages and to the formation of cysts. Rich in cells throughout its entire extent and involving mesoderm as well as ectoderm, this type of tumor assumes the character of a sarcoma. Some of the tumors appear in the form of solid clumps; others are more or less diffuse. The clinical picture of these neoplasms is characterized by a paucity of symptoms which is in perfect harmony with their short duration. The symptomatology closely resembles that of multiple sclerosis. Incomplete cranial nerve palsies are frequent in spite of the fact that the lesions are either nuclear or radicular. The condition of the deep and superficial reflexes also resembles that in multiple sclerosis. To complicate matters, many of the cases reported were characterized by remissions. The association of such a symptom-complex with general symptoms of tumor of the brain, however, is sufficient to suggest the presence of a glioma in the pons and its adjacent structures.

The case reported in this paper was one of tumor which began in the most ventral portion of the anterior third of the pons and reached its greatest size in the middle of that structure without invading the stratum profundum; caudad, the tumor extended in the form of two cones over the medulla with the ventral cone superimposed over the pyramids and with the dorsal cone over the substantia reticularis between the spinal root of the trigeminus and the olive. The growth occupied the right side of the medulla and just before reaching the pons crossed over to the left side of the medulla; it did not involve the pyramidal decussation.

It was an infiltrating growth; in the area in which the growth was of longest duration — the pons — the pontile fibers were completely destroyed, whereas in the more recently involved areas the fibers appeared separated from one another. The spinal cord was not available for examination, and as the tumor did not extend to the pyramidal decussation, it could not be ascertained whether or not the pyramidal tracts in the cord were degenerated. At any rate, it was striking that, in spite of the fact that many of the arcuate fibers were within the tumor area, neither the lemniscus nor the restiform body showed any evidences of degeneration. The cerebellum, as well as the nuclei within the tumor area, also seemed to be intact. The tumor itself was an extremely cellular glioma; owing to its extension to the pia and its close relationship, it would have been regarded in previous years as a gliosarcoma.

It is noteworthy that the tumor, which occupied two thirds of the pons and a considerable part of the medulla, caused comparatively few symptoms. At the onset, there was only an involvement of all branches of the right facial nerve, the left facial not being involved until just before death; the same was true of the soft palate; speech was somewhat slow, and only immediately preceding death was there any evidence of pontile bulbar paralysis. Another striking feature was the preservation of voluntary motor power in all extremities in the presence of a severe involvement of both pyramids. It was also note-

worthy that the abdominal reflexes were lively; the patellars showed clonus and the ankle reflexes could barely be elicited. In the presence of general symptoms pointing to the presence of tumor, such disproportion of superficial and deep reflexes would seem to be in favor of glioma, because it is precisely in this type of tumor, just as in multiple sclerosis, that large numbers of nerve fibers, especially the axons, escape destruction. Although the general symptoms of tumor of the brain were evident, its precise localization was extremely difficult to determine. Symptoms characteristic of pontile involvement were conspicuous by their absence; nevertheless, the presence of horizontal and vertical nystagmus with the early onset of a complete peripheral facial paralysis was extremely suggestive of such a localization; the later appearing, but definitely progressive, bulbar paralysis merely pointed to an extension of the pathologic process.

KESCHNER, New York.

CALCULATION DISTURBANCES IN FOCAL LESIONS OF THE BRAIN. H. BERGER. Archiv. f. Psychiat. u. Neurol. **78**:238 (Sept.) 1926.

This article contains a discussion of calculation disturbances resulting from organic disease of the brain and their relation to disturbances of other intellectual functions, as well as the possibility of a localizable center. A review of the literature shows that calculation disturbances are met with in cases of circumscribed lesions of the brain (tumors, wounds, etc.) where there are slight, if any, disturbances of other intellectual functions, especially of formal logical judgment. Most observers believe that such disturbances are found in cases of lesions of the occipital lobe (either bilateral or left). Some authors go so far as to claim a relatively independent center for arithmetical processes.

In his own cases, the author distinguishes between: (1) calculation disturbances as a result of disturbances in other cerebral functions, i. e., *secondary*, and (2) calculation disturbances that appear to be independent of those of other functions, which he calls *primary*. Of the two types, the first mentioned is by far the more frequent. The author reports a series of cases of this type. In some the difficulties are dependent on disturbances of attention and memory; these are mostly found in cases of tumors of the brain. In one case, the fluctuating increase of intracranial pressure was associated with periods of psychic disorder showing secondary calculation disturbances. They may occur as part of the process known as perseveration in organic diseases. The disturbance here shows itself in different forms. At times the patient answers the first question correctly, but to all subsequent problems this answer is repeated. At others, if the first problem is one of multiplication, the subsequent problems, irrespective of denomination, are submitted to the same process. In others, again, the last number in the problem given is repeated by the patient as the answer.

Secondary calculation disturbances also occur in connection with aphasia, agraphia and dysarthria. In such conditions, however, it is found that in a pure aphasia the patient gives the wrong answer verbally, but can give the correct answer in writing, and vice versa. Some investigators of normal and abnormal psychology come to the conclusion that the four arithmetical processes can be ranged according to the difficulty in performance as follows: multiplication, addition, subtraction and division. Another grouping can be based on the conceptual relation between subtraction and addition, and a similar relation between division and multiplication.

Patients with primary calculation disturbances, those that do not depend on defects in other intellectual fields, show inability to perform such processes that

are related, in accordance with the groups given. The first patient had a tumor in the left temporo-occipital region. He could do addition and multiplication perfectly, but subtraction and division could not be done either verbally or in writing. There were some disturbances of speech and neurologic symptoms, but otherwise the man was normal, psychically and intellectually. The second patient had a tumor in the precuneus, which invaded the corpus callosum. Here, too, there were aphasia and paraphasia. He could add and multiply easily, but subtraction, and especially division, could not be performed. A third patient, who had a gliosarcoma of the left thalamus which was breaking its way through the temporoparietal lobe, also showed primary calculation disturbances. Addition and subtraction were done well, but even the simplest problems in multiplication or division could not be performed. In this case again, the disturbance could not be traced back to difficulties in any other intellectual field.

The author concludes that only primary calculation disturbances can be utilized for purposes of localization. His observations do not confirm the existence of a special center. One finds these disturbances, however, most frequently in cases of lesions of the left occipital and left temporal lobes (in right-handed persons). It seems that lesions of the temporal lobe give rise to disturbances in conceptually related functions, whereas lesions of the occipital lobe tend to interfere with optically related functions and disturbances in the concept of numbers in general.

MALAMUD, Foxborough, Mass.

CHRONIC EPIDEMIC ENCEPHALITIS. WALTER FREEMAN, J. A. M. A. **87**:1601 (Nov. 13) 1926.

The author endeavors to prove that the so-called sequelae are in reality a chronic stage of epidemic encephalitis. The disease seems to be on the increase and is causing grave concern. The initial mortality is over 30 per cent, and over 70 per cent of those who recover from the acute attack show manifestations varying from mild conduct disorder to complete physical disability. Encephalitis has been reportable for a considerable time, but the patients have been kept in general wards and little precaution has been taken to prevent the spread of the infection; fortunately, the acute disease is only mildly contagious. The possibility of contracting the disease from those who had suffered an acute attack months or years previously has seldom been considered.

In his effort to prove that the later manifestations are really due to the persistence of the pathologic agent as thought by former workers and not, as thought in this country, to sequelae, Freeman presents his evidence under four headings.

After a brief account of the acute attacks, he describes the latent stage in which the patient may even return to work. He takes up the development of the typical parkinsonian syndrome, and also mentions other forms that the chronic disease may take, such as hyperkinetic forms, respiratory arrhythmias, disorders of conduct and mental derangements. The author believes that the history of epidemic encephalitis with its latent periods, its remissions and exacerbations, its slowly progressive course and termination in death many months after the acute onset points unmistakably to persistence of the causative agent.

Pathologic studies of five fatal cases also point to this persistence. The mesencephalon, in which the lesions were most marked, showed marked destruction of ganglion cells in the locus niger. More important was the presence

of fat in the scavenger cells; even more significant was the collection of small numbers of lymphocytes within the sheaths of blood vessels. These observations are in accord with those of other workers.

Bacteriologic evidence is then presented. Freeman and Miss Evans of the U. S. Public Health Service succeeded in isolating from three cases a streptococcus identical with that described by von Wiesner and Rosenow; inoculation of rabbits and monkeys caused acute or subacute meningo-encephalitis. From two cases at necropsy they failed to secure the organism, but in two cases of four and six years' duration, respectively, it was obtained from the heart blood and the midbrain; from these they had also obtained it in the nasal washings some time before death. The same organism was found in the spinal fluid in two of three chronic cases and in the blood and spinal fluid from two acute cases. If this organism is the causative agent of the disease, parkinsonism (of encephalitic origin) is a chronic disease.

Epidemic encephalitis is mildly contagious during the acute stage. Freeman presents seven cases in which acute encephalitis developed in persons who had been in close association with patients suffering from the disease in its chronic stage or during an acute exacerbation long after the original attack. Freeman believes that the term "postencephalitic disorder" is a misnomer, and that it should be called chronic epidemic encephalitis. He emphasizes that treatment should not end with recovery from the acute attack, but that the disease should be combated in the latent interval, and that there is a challenge to find a satisfactory method of exterminating the virus.

CHAMBERS, Syracuse, N. Y.

ETIOLOGY OF ENCEPHALITIS FOLLOWING VACCINATION AGAINST SMALLPOX. C. LEVADITI, S. NICOLAU and V. S. BAYARRI, Presse méd. **35**:161 (Feb. 5) 1927.

The authors state that over 100 cases of encephalomyelitis following vaccination have been reported from Europe within the last three years, the earliest observation of such a sequela having been made in 1912. The following hypothetic etiologies are discussed: (1) the vaccine virus might be exceptionally neurotropic and so itself effect an encephalomyelitic localization; (2) encephalomyelitis might have been incubating or latent, and have been excited by the vaccination; (3) a virus hitherto unknown might be responsible.

Referring to the first hypothesis, if inoculations made from an affected nervous system have produced vaccinia pustules, the latter may be ascribed to the probable presence of vaccine virus in the nervous system after ordinary vaccination, without that virus having been responsible for encephalomyelitis. Experiments by Levaditi and others show that "neurovaccine" (Levaditi and Nicolau: *Ann. Inst. Pasteur* **37**:2, 1923) inoculated cutaneously into monkeys appears in the neuraxis in small quantities eight or ten days afterward without causing encephalitic lesions capable of killing the animal.

Biologic examination of a specimen from one of those stocks, the use of which had been followed by encephalomyelitis in the child vaccinated, showed that the specimen was not more neurotropic (in animals) than were specimens from other lots of vaccine that had been used without causing encephalomyelitis in man. Neurovaccine inoculated intracerebrally into apes produced an acute hemorrhagic and inflammatory meningitis, with a small abscess at the point of inoculation; but there was no extension of inflammatory reaction into the parenchyma or along the vessels of other segments of the central nervous system. The difference between this histologic picture and that of postvaccinal

encephalomyelitis, seemed sufficiently marked to justify the authors' conclusion that the two conditions were different; vaccine, at least, was not itself the cause of the postvaccinal process, and some other virus must be responsible. Finally, a stock of neurovaccine (cultivated for several years in the brain of a living rabbit and believed to be free from any accompanying viruses) has been used by Gaillardo and his associates in Spain for nearly two and a half million vaccinations, without a single postvaccinal encephalomyelitic sequela.

On the other hand, direct evidence for the second hypothesis, that the postvaccinal disease is a genuine epidemic encephalitis lighted up by the vaccination is found in the identity between the morbidity curves of the two encephalitides, and in an analogy with herpeto-encephalitis, to which the neuraxis is rendered more susceptible by previous vaccinia inoculation.

Evidence against the third hypothesis appears in the negative results of cutaneous inoculation of rabbits with neurovaccine and herpeto-encephalitic virus simultaneously. Herpetic encephalitis could not be produced, apparently because the vaccine virus destroyed the activity of the other at the point of inoculation. This conclusion seemed to leave the field clear for acceptance of the second hypothesis.

HUDDLESON, New York.

GLIOMA OF PONS VAROLII SIMULATING A FRONTOMOTOR TUMOR. T. B. THROCKMORTON, J. A. M. A. **87**:1731 (Nov. 20) 1926.

Infratentorial tumors produce general symptoms early, while stem growths produce local symptoms early with latent general symptoms. Throckmorton reports a case which, although pointing to definite involvement of the brain stem, savored largely of frontomotor involvement. A man, aged 56, was seen on Oct. 3, 1922, complaining of weakness of the right arm and leg, double vision, fulness in the head, vomiting and thickness of speech of about three weeks' duration. He had noticed some diminution of hearing in the right ear for some years. In the summer of 1922 he had noticed a "queer feeling" in the head when he stepped on an uneven surface. He could regain his balance and did not fall, but he felt a lack of power to prevent falling in case it did take place. Associated with this was forgetfulness and emotional instability. In September, 1922, he noticed that jarring produced pain in the neck. If he arose suddenly, he had to sit on the edge of the bed before walking to prevent a "dancing" feeling in the head. Weakness of the right arm and then of the right leg soon developed. Headache and diplopia appeared, with thickness of speech and numbness and tingling in the right arm and leg. Some sensory aphasia developed, and a day or two later severe attacks of vomiting sent the patient to bed.

The positive symptoms on examination were: tenderness to pressure in the left suboccipital region, nystagmus to the right with vertical nystagmus on upward rotation. There was diplopia on looking to the left due to weakness of the left external rectus. There was only slight fulness of the retinal veins; weakness of the lower quadrant of the face with some drawing of the palate to the left side without trigeminal involvement and slurring of speech and slowing of mental processes. The hearing was greatly reduced in both ears. The patient had muscular weakness of the right side with exaggerated tendon reflexes and a positive Babinski sign; the abdominal and cremasteric reflexes were absent on the right. There was right-sided astereognosis. Sensory changes were not present. Laboratory and roentgen-ray tests gave negative results, except that there was cystitis.

The patient became worse, lost hearing in the left ear, became more emotionally unstable and was referred to the Mayo Clinic, where the foregoing symptoms were corroborated. He developed pneumonia and emphysema and died. Necropsy revealed a hemorrhagic glioma of the left half of the pons, although the symptoms pointed to a prefrontal lesion.

The author believes that it is possible to have symptoms referable to a prefrontal lesion when only a lesion of the brain stem can be demonstrated. He also believes that vertical nystagmus is an important localizing symptom of involvement of the brain stem.

CHAMBERS, Syracuse, N. Y.

THE PSYCHIC INFLUENCE OF COCAINE AND ITS SIGNIFICANCE IN PSYCHOPATHOLOGY. A. JACOBI, Arch. f. Psychiat. u. Nervenk. **79**:383 (Jan.) 1927.

In 1921, Berger first investigated the effect of injections of cocaine in catatonic stupor. In most of his cases there was a temporary disappearance of some of the catatonic symptoms. Berger then advanced the theory that catatonic stupor, no matter what its psychogenic cause and psychologic value, has a physiologic component in the form of an inhibition of the normal catabolic process in the cerebral cortex. This inhibition is removed by the cocaine, and with that the stupor disappears. He based his conclusions on the fact that cocaine causes an increase in the pulse rate and body temperature, and that this change in temperature must be of cerebral origin, because it is counteracted by chloral hydrate which had no influence in a case of artificially induced bacterial fever.

The author studied the effect of injections of cocaine on two normal persons and twenty-four psychotic patients. In the former there was an increase in pulse rate with moderate euphoria, distractibility of attention, a certain degree of press of speech, and inability to concentrate. This lasted for about twenty-five minutes. The psychotic material investigated consisted of eighteen cases of schizophrenia, two cases of manic-depressive psychoses, one case of presumably psychogenic stupor in general paralysis, one case of epileptic stupor, one of arteriosclerotic depression and one of Pick's atrophy.

There is a detailed review of the behavior in the different cases which can be summarized as follows: In sixteen of the twenty-four there was a distinct change in the form of: increased facial grimacing, motor excitement of different degrees, in some reaching the extent of a "motility psychosis." The mutism was broken through in most of the cases, to reach even a spontaneous press of speech in some. In seven cases of the twenty-four, a rapport was obtained which was previously impossible, and in other cases the previous poor rapport was improved. In cases of depression he obtained a variable degree of euphoria temporarily.

The author comes to the following conclusions: 1. Stupors of different types may be influenced by subcutaneous injections of from 50 to 200 mg. of cocaine. 2. This influence is probably caused by a central excitement. 3. The differences in effect on different patients depend on individual factors such as personality and development of psychoses. 4. In this way one can obtain a better insight into the mechanism of the disease in some cases. 5. The influence on the vegetative nervous system consists in increase of pulse and respiration rates, widening of the pupils, decreased activity of the salivary glands, tremor and sometimes nausea. 6. The effect is temporary and therefore without therapeutic value.

MALAMUD, Foxborough, Mass.

THE EPIDEMIOLOGY OF POLIOMYELITIS. WITH REFERENCE TO ITS MODE OF SPREAD. W. L. AYCOCK, J. A. M. A. **87**:75 (July 10) 1926.

The most widely accepted theory concerning the mode of spread of poliomyelitis is that of direct contact through the upper respiratory passages. Support for this theory is found in the detection of the virus in the upper respiratory passages in active cases, abortive cases and healthy contacts; but epidemiologic evidence is scant, being about 5 per cent. The discrepancy has been met by the assumption of a comparatively large proportion of mild, unrecognized forms of the disease and of healthy carriers.

Age distribution and serum neutralization are pointed out as facts indicating a much more widespread distribution of the virus than recognizable cases would indicate. The former corresponds closely to the age distribution of measles, scarlet fever and diphtheria. In urban districts the peak of incidence is from 2 to 3 years, while in rural districts the age incidence is relatively higher, after 5 or 6 years. This difference suggests that the greater person-to-person contact in congested districts results not in greater incidence (indeed the reverse is true) but rather in a more widespread distribution of the virus and an undisputed immunization. The latter may be caused by subinfective doses of the virus in concentrated populations rather than by mild attacks of the disease. Some serums of normal persons have viricidal properties, and it is suggested, although the limits of serum neutralization are not yet clearly defined, that these persons are immunized. This is also evidenced by the absence of viricidal properties in the serum of normal monkeys and their presence after the experimental disease or artificial immunization.

Under the conception of the distribution of the virus, the paralytic case has been relatively infrequent, intervening missed cases and healthy carriers explaining the lack of traceable relationship between recognized cases. However, the extent of occurrence of abortive cases and the distribution of healthy carriers can only be hypothesized. Observations of the occurrence of poliomyelitis in Vermont over a period of years has borne out the idea that direct contact can seldom be considered as causing the disease; on the other hand, the time and space relationships in these cases suggest a more definite connection than is implied in the abortive case, healthy carrier theory of transmission. A study of the cases indicates that simultaneous infection was the cause in most cases and secondary infection in the others. Aycock supports this contention with tables.

He concludes that paralytic poliomyelitis, while not infrequently transmitted from person to person, is not conveyed by direct contact nor by abortive cases or healthy carriers but by some indirect means, a recent outbreak having pointed to milk as the source.

CHAMBERS, Syracuse, N. Y.

THE MECHANISM OF PAIN IN GASTRIC AND IN DUODENAL ULCER: II. THE PRODUCTION OF PAIN BY MEANS OF CHEMICAL IRRITANTS. WALTER L. PALMER, Arch. Int. Med. **38**:690 (Dec.) 1926.

A considerable array of evidence is presented to demonstrate that pain is produced in cases of peptic ulcer by the acid content of the gastric juice. The method used was the injection, under strict time conditions, of 400 cc. of 0.5 per cent hydrochloric acid by the Rehfuss tube into the empty stomach. In thirty normal persons used as controls, pain was produced in none, although a certain amount of nausea and vomiting occurred in a small proportion. In twenty-five patients with ulcer, typical distress was not produced by the injection; but in

eighty-four patients with ulcer, typical distress was so induced. The distress was relieved by neutralization of the acid, or by removal of the chemical irritant from the stomach. Furthermore, in certain cases the pain was produced by other chemical irritants, such as sulphuric acid, acetic acid, and sodium hydroxide. As disappearance of pain followed neutralization in all these cases, the author feels justified in attributing it to the direct action of the acid or base. No evidence is found to support the idea of hyperesthesia of the gastric mucous membrane or of pain due to hyperchlorhydria with an intact mucous membrane.

THE MECHANISM OF PAIN IN GASTRIC AND IN DUODENAL ULCER: III. THE RÔLE OF PERISTALSIS AND SPASM. W. L. PALMER, Arch. Int. Med. **39**:109 (Jan.) 1927.

This paper concludes a series on the general subject of the mechanism of the production of pain in ulcer. Experiments are reported on the rôle of local spasm and peristalsis as a stimulus to the pain-producing mechanism in peptic ulcer. The methods consist of the Cadson balloon tracings and roentgenologic studies. The conclusion is that, except in sensitive ulcers, the pain inciting stimulus is not gastric or duodenal tone or motility, or local pylorospasm. Some study of carcinoma pain is included, with the statement that the same factors operate here as have been shown in previous papers on ulcer, i. e., acid irritation and occasionally peristalsis.

ANDERSON, Philadelphia.

THE RELATIVE VOLUMES OF THE THREE EPITHELIAL PARTS OF THE HYPOPHYSIS CEREBRI. WAYNE J. ATWELL and EVERETT A. WOODWORTH, Anat. Record **33**:377 (Sept. 25) 1926.

The major purpose of this study was to determine whether the relative size of the pars tuberalis as compared with the other epithelial portions of the hypophysis (pars anterior and pars intermedia) justifies its inclusion as a potent factor in a consideration of the total function of the gland. In addition the authors aimed to determine whether the pars tuberalis is relatively smaller in the higher vertebrates. By using the projection microscope with paper of standard weight and then weighing the carefully outlined and cut-out drawings of the three epithelial portions, quantitative comparisons were possible. The stroma of the pars tuberalis makes up about 50 per cent of its total. This correction must be made in final comparison.

In *Urodeles,* considerable variation among the various species was found. Individuals in the same species, however, showed fair uniformity. In the *Anura (Rana pipians)* the pars tuberalis had a strikingly lower relative value. The pars anterior in the cat formed about 75 per cent of the total epithelium, whereas the pars intermedia and pars tuberalis were approximately 16 per cent and 9 per cent respectively. In the new-born human the pars tuberalis (including stroma) and pars intermedia have about the same value (total 5 per cent).

On the basis of the few animals studied it seems as though, with increase in body weight, the relative value of the pars anterior and pars tuberalis decreases, while that of the pars intermedia increases. Sex and pregnancy influence the size of the hypophysis. Probably 95 per cent of the increase during the latter state is due to increase in the pars anterior. The authors conclude that since in some vertebrates, including man, the pars tuberalis is equal, or nearly equal, in size to that of the pars intermedia, the former may be capable of an important secretory function.

WOLFF, Boston.

STOVARSOL IN THE TREATMENT OF SYPHILIS. FRANK W. CREGOR and FRANK M. GASTINEAN, Arch. Dermat. & Syph. **15**:43 (Jan.) 1927.

Nervous symptoms have been noted following the use of sodium arsanilate and other arsenical preparations in the treatment of syphilis. In 1921, M. Fourneau, in conjunction with Trefonel and Navarro-Martin, published a note on investigations with a pentavalent form of arsenic. This product is known as stovarsol. It is a white crystalline powder, readily soluble in water, tasteless and easily utilized by the digestive tract and contains about 7 per cent more arsenic than neoarsphenamine. It can be administered orally. The authors report results in fifteen cases. Two methods of administration were used: (1) continuous, in which the patients were given from two to four tablets (0.5 to 1 Gm.) dissolved in water one-half hour before breakfast every morning; (2) intermittent, in which the patients received from ten to twelve tablets (2.5 to 3 Gm.) divided equally over four days, and then were allowed to rest for three days. A course consisted on an average of 15 Gm. of the drug. Constant observation of the patient and frequent urinalyses were made.

The cases selected were of more than moderate severity. All patients had a sense of well-being while under treatment. The average patient gained in weight and vitality; this was especially true in the more severe cases. In a few cases, mild headache, slight elevation of temperature and a metallic taste in the mouth were noted. Stovarsol was used in the treatment of primary, secondary and tertiary syphilis. The condition was resistant to treatment in only one case, and that was of the severe rupial type. The authors are convinced that the tolerance for stovarsol is high compared to that for other arsenicals, and that its efficiency is comparable to that of neoarsphenamine. They believe that it is valuable in aborting syphilis. The dosage, however, is not well established. A later report will give the results of a series of observations on syphilis of the central nervous system.

WAGGONER, Philadelphia.

TREATMENT OF CHRONIC ABSCESS OF THE BRAIN BY TAPPING. WALTER E. DANDY, J. A. M. A. **87**:1477 (Oct. 30) 1926.

In a preliminary note, Dandy emphasizes that drainage in the brain is a different problem from drainage of abscesses elsewhere in the body, owing to the differences in structure. The brain is delicate and well protected, and reacts slowly, weakly and less effectually to trauma produced by drainage. In addition to the actual operative trauma, he calls attention to the irritation produced by gauze and tubing, both resulting in cerebral edema; the surrounding infection invading the injured brain produces a complicating encephalitis.

Nature is constantly hampered by the limited space available, and the drainage of the abscess with its associated edema and swelling exact an ever increasing amount of intracranial room in addition to that caused by the abscess itself. Then, too, the cerebral fungus extending through the opening in bone, dura and skin still further increases the effects of trauma and infection, again increasing intracranial pressure, and there are further protrusion and a vicious cycle.

The occasional spontaneous cure of abscesses of the brain and the occasional transition from an acute to a chronic walled-off abscess led Dandy to treat chronic abscess by making a small perforator opening in the bone over the abscess and introducing a ventricular needle into the abscess through a tiny nick in the dura, leaving the needle in place until the pus ceased to drip.

No irrigation or aspiration is done and the cutaneous wound is tightly closed. This procedure, Dandy states, is of proved value for chronic abscesses only; he believes that acute abscesses present a far less hopeful outlook.

CHAMBERS, Syracuse, N. Y.

THE MORPHOLOGY OF THE TEMPORAL LOBE. OTTO MARBURG, Arb. a. d. Neurol. Inst. a. d. Wien. Univ. **28**:1 (May) 1926.

The temporal lobe really consists of two large divisions, a mesial (the hippocampus) and a lateral, which is designated as the temporal lobe proper. Each of these divisions is subdivided into three parts which present evidence of a progressive type of development: (1) The lateral part, derived from the temporal convolution, which owes its progressive development to the gyri transversi; (2) Temporal convolutions II and III, which may be regarded as one unit the components of which cannot be clearly distinguished on account of the indistinctness of their boundary lines, and which give rise, in the course of their further development, to a more massive "cortex relief"; (3) The gyrus fusiformis, derived mostly from the lateral division which is distinct in apes and forms a massive structure in man. The mesial division is subdivided into (1) the cornu ammonis region, and (2) the hippocampus, supplemented by the lobulus lingualis, which attains its highest development in man; these two areas are apparently united with each other through the intervention of the temporal pole and its convolutions, as well as with other transitional convolutions extending in various directions. The caudal borderline of the temporal lobe is formed by the bifurcation of the collateral fissure and that of the first temporal fissure. This borderline is frequently obscured on account of the development of transitional convolutions, which can also be recognized as a phylogenetic anlage. A large part of what is usually regarded as a variation in the convolutional picture is merely an advanced stage of development or a phylogenetic regression.

KESCHNER, New York.

EXPERIMENTAL RESEARCH ON THE PATHOGENESIS OF HYDROCEPHALUS. E. D'ABUNDO. Neurologica **5**:257 (Oct.) 1926.

The author tries to elucidate experimentally the complicated question of the pathogenesis of hydrocephalus. In his three series of experiments followed by hydrocephalus, he deals first with subcortical lesions, which resulted in the formation of cysts in direct communication with the ventricular cavities. In the second series, the resulting cyst was separated from the lateral ventricle by means of a more or less thick layer of nervous parenchyma; in the third series, he deals with ligature of the right carotid artery which was followed by a localized area of softening in the brain. In the second series, in which no direct lesion of the ventricular wall was produced, the hydrocephalus was due, according to the author's view, to the vascular hyperemia which he was able to trace and which was the expression of the inflammatory reaction following the operation. The hyperemia might have influenced, directly or indirectly, the formation of the hydrocephalus. According to the author, the inflammatory lesions play an important part in the mechanism of the formation of hydrocephalus in cases involving the ventricular walls, either directly or indirectly.

From the pathologic point of view, the most important observations were the subependymal gliosis shown by the presence of numerous astrocytes, and the lesions of the choroid plexus shown by the presence of swollen and

vacuolated cells of the secretory epithelium. The anatomic lesions were marked in from seven to eleven days after the operation, and showed a tendency toward regression in patients examined twenty-five days later. For the intimate pathogenesis of hydrocephalus the author invokes, besides the circulatory changes, other factors that should be investigated further.

FERRARO, New York.

DEGREE OF MENTAL DEFICIENCY RESULTING FROM CONGENITAL SYPHILIS. NEIL DAYTON, J. A. M. A. **87**:907 (Sept. 18) 1926.

There is a prevailing opinion that congenital syphilis is of serious import as a cause of mental defect. Dayton, believing congenital syphilis to be a less important cause than the statistical 7.8 per cent incidence would indicate (small groups of selected cases from European literature), assembled data based on American statistics (1910-1925) and found that 5.3 per cent of the feebleminded in this country have congenital syphilis. This is 1 per cent higher than the percentage of children who are not mentally defective. Dayton's work at the Wrentham State School tended to negate this higher incidence, as several cases presented etiologic factors which would render mental defect inevitable regardless of syphilitic infection. Hence, he concludes that congenital syphilis is not a prominent cause of mental deficiency.

Dayton made an attempt to determine the extent of mental defect present in feebleminded children with congenital syphilis. He presents two charts and a table. He reviewed all the records of the Wrentham State School from the standpoint of chronologic ages and mental ratings and found that in those in whom Wassermann tests were made there were 1,956 negative, sixty-eight positive and twenty-one doubtful reactions. He concludes that the intelligence of sixty-one mentally defective children with congenital syphilis is definitely above that in the 1,956 cases due to other causes. Congenital syphilis does not produce large numbers of cases of mental deficiency. So from both the qualitative and the quantitative point of view, congenital syphilis is not a serious factor in the production of mental deficiency.

CHAMBERS, Syracuse, N. Y.

THE NATURE OF CREMASTERIC REFLEXES. G. ARONOVITCH, J. Nerv. & Ment. Dis. **64**:235 (Sept.) 1926.

The application of biologic analysis to the symptomatology in nervous diseases has already thrown light on lesions of the pyramidal tract and hemiplegic contractures. In such lesions, the cremasteric reflex less often disappears completely on the affected side of the body than the abdominal, and is hence less useful as a means of diagnosing involvement of the pyramidal tract. The author finds that in disseminated sclerosis lower abdominal reflexes disappear earlier than the upper abdominal and the cremasteric. Although the reflex arcs of all the abdominal reflexes pass through the dorsal segments seven to twelve and the cremasteric reflex through the first lumbar, their reflexogenic zones frequently overlap and the reciprocal reinforcing influence of one reflex on the other renders it impossible to explain the disappearance of the abdominal and the retention of the cremasteric reflexes on anatomophysiologic grounds. Mammals have a belly skin reflex, but no abdominal reflex in which the abdominal muscles contract. Even in apes, abdominal reflexes are absent; hence, the author associates the appearance of the abdominal reflex with the assumption of the vertical posture in man. New-born children have no abdominal reflexes; yet the early appearance of the cremasteric reflex in infants

and its frequency in dogs, bulls, stallions and other animals leads the author to the conclusion that the cremasteric reflex is an earlier and older reflex, both phylogenetically and ontogenetically. This difference may then account for the unequal intensity of abdominal and cremasteric reflexes in pyramidal tract regions.

HART, Greenwich, Conn.

SECONDARY TUMORS OF THE BRAIN. W. D. SHELDEN, J. A. M. A. **87**:650 (Aug. 28) 1926.

Shelden states that about 5 per cent of the tumors of the brain examined at the Mayo Clinic have metastasized from malignant disease elsewhere in the body. Many times patients present themselves with symptoms of tumor of the brain as the initial evidence of malignant disease elsewhere. The author stresses the importance of a thorough history and physical examination when a case of tumor of the brain presents itself. He cites two cases in detail as illustrations. He then presents three tables of classifications of cases of metastatic tumor of the brain. In group 1 are cases of latent malignant disease, the initial symptoms being due to cerebral metastasis. In group 2 are cases of malignant disease without symptoms but which are demonstrable on examination, the initial symptoms being cerebral. In group 3 are cases of surgical removal of malignant growth with cerebral symptoms as the first evidence of recurrence. In group 4 are tumors which during their clinical course metastasize to the nervous system with or without the production of symptoms. Shelden concludes that metastatic tumors do not present any essentially different characteristics from primary tumors of the brain; that all patients presenting symptoms of tumors of the brain should be carefully studied for secondary or primary lesions elsewhere, and that roentgenograms of the chest and skull should be taken when cerebral symptoms appear.

CHAMBERS, Syracuse, N. Y.

A HITHERTO UNOBSERVED STRUCTURE IN THE BRAIN OF SOME MAMMALS: THE SUBFORNIX OF THE THIRD VENTRICLE. J. L. PINES, J. f. Psychol. u. Neurol. **34**:186, 1926.

Pines found the subfornix in the lemur, dog, mouse and hedgehog. Its histologic structure is the same in all of these animals. Its size varies; it is much larger in the lemur than in the dog. Its unusually rich blood supply as well as its location would seem to suggest that its function is secretory in nature—a gland which might be designated as "glandula subfornicata ventriculi tertii." The similarity of this structure to the epiphysis is striking. It may also be of some significance that the epiphysis is in the caudal portion of the interbrain, at its mesencephalic boundary line, whereas the subfornical organ is located in the oral portion of the thalamus where the latter borders on the forebrain. Another interesting feature is its relation to the ventricular ependyma and choroid plexus. The subfornix is really extraventricular because it is separated on all sides by its epithelial layer from the third ventricle. Embryologically, it would seem that it is developed from the original wall of the ventricle and becomes wedged into the latter on account of the development of the fornix. The apparently constant occurrence in mammals of a "gland" of this type, as well as its location at the site of communication between the third and lateral ventricles, seems to leave no doubt that it must be an organ of considerable significance to the nervous system.

KESCHNER, New York.

THE SIGNIFICANCE OF ACHLORHYDRIA. WILLIAM FITCH CHENEY, J. A. M. A. **87**:22 (July 3) 1926.

Although this paper is primarily of interest to internists, certain parts of it warrant an abstract. Cheney calls attention to the fact that the symptoms and signs of subacute combined degeneration of the spinal cord are exactly similar to those sometimes found in the course of pernicious anemia. These symptoms may occur in a patient who does not show signs of anemia, even when a fatal issue occurs. Collier believed that changes in the blood do appear ultimately, although they may be delayed several years.

It has been discovered recently that practically every case of subacute degeneration of the spinal cord shows achlorhydria, as does practically every case of pernicious anemia. Achlorhydria is then a serious sign as regards prognosis. However, achlorhydria may not always mean pernicious anemia, malignant disease, disease of the biliary tract or disease of the cord, for it is seen in visceroptosis with neurasthenia, in neurasthenia without visceroptosis and in hysteria. Experience shows, however, that hypersecretion is a much more frequent result of disturbed innervation than is hyposecretion or absent secretion. Achlorhydria may be functional at the outset, but who can say that its presence may not lead to changes in the blood or the cord produced by toxins, which the absence of free hydrochloric acid permits to develop in the intestinal tract?

CHAMBERS, Syracuse, N. Y.

THE RELATION OF MENSTRUATION TO THE PERMEABILITY OF THE SKIN CAPILLARIES AND THE AUTONOMIC TONUS OF THE SKIN VESSELS. W. F. PETERSEN and GEORGE MILLES, Arch. Int. Med. **38**:730 (Dec.) 1926.

Examination of capillary permeability was carried out in a series of normal young women, according to a technic described in the preceding number of this journal. It is shown that in the premenstrual and menstrual periods the blister time is shortened over that in the intermenstrual phase. The ratios are specifically: intermenstrual, 0.72; premenstrual, 0.75; menstrual, 0.77. A discussion follows concerning the autonomic imbalance preceding menstruation; it is stated that in the premenstrual phase the skin is parasympathetically oriented, while with the onset of the menstrual phase the skin becomes sympathetically controlled, with parasympathetic preponderance in the splanchnic area. The specific problem interesting the authors is the relation of this imbalance to infectivity in tuberculosis, since both focal and constitutional reactions are enhanced during menstruation in this disease. An interesting point, too, is that certain drugs, used on the basis of their autonomic action, also possess more primitive, protoplasmic effects. Thus, agents inducing increased permeability by direct action on the cell membrane, for example, thyroxin and pilocarpine, act parasympathetically; whereas epinephrine, pituitary extract, and insulin induce decreased permeability by direct action, and act sympathetically. Menstruation is probably a resultant of ionic, endocrine, and autonomic changes.

ANDERSON, Philadelphia.

RESEARCHES ON THE SYMPATHETIC SUPRARENAL LESIONS IN SOME SYMPTOMATIC DEPRESSIVE SYNDROMES. SALVATORE DE LEO, Neurologica **5**:284 (Oct.) 1926.

The author describes two cases of depression, one of which occurred in the course of a senile psychosis and the other in the course of general paralysis. In both cases he examined the sympathetic celiac ganglia and the suprarenals. In the ganglion cells in the first case he found lesions of acute type leading to disin-

tegration of the cell body. Lesions of the dendrites and of the axons were also found. In the suprarenals the most striking feature was degeneration of the medullary cells, a small infarct, and vacuolization of the cortical elements. In the second case, the lesions of many cells in the sympathetic ganglia were more of the atrophic type, while some cells showed fatty degeneration. Lesions of the dendrites and of the axons were also marked. In the suprarenal there was hyperemia of the zonia reticulata, besides a few small focal hemorrhages. The chromaffin cells were swollen, with homogeneous cytoplasm and degenerated and poorly stained nuclei. The lesions may, according to the author, have influenced the onset of the depressive features in the two types of psychoses. The lesion of the sympathetic ganglia particularly may influence the development of hypochondriac delusions, especially in patients with defective judgment, while the lesions of the suprarenals may facilitate the accumulation of toxic substances which act on the cerebral cortex. The depressive conditions at times accompanying Addison's disease, suggest a suprarenal origin for the depressive syndrome.

FERRARO, New York.

SPINAL ANESTHESIA. HARRY W. MARTIN and RACHEL E. ARBUTHNOT, J. A. M. A. **87**:1723 (Nov. 20) 1926.

This article is a review of over 6,000 cases in the Los Angeles General Hospital with especial consideration of genito-urinary operations, but it has some interest for neuropsychiatrists. The authors define this type of anesthesia as a root anesthesia produced by the injection of an anesthetic agent into the subarachnoid space. There is a brief history of spinal anesthesia, with a consideration of the operations in which it is the anesthesia of choice and those in which a general anesthetic is preferable. Contraindications are considered. Discussion of the six deaths that occurred follows. Preparation and technic are discussed and conclusions follow, which are briefly: (1) the fall in blood pressure is greater than with any other anesthetic; (2) light gas oxygen anesthesia increases the safety and desirability of spinal anesthesia; (3) central drugs are valueless and only peripheral pressor drugs are of value; (4) blood pressure readings should be taken frequently; (5) the morning cup of black coffee or orange juice is beneficial; (6) patients should usually have a preliminary opiate; (7) needles should be small and made of nickel or nickeloid; (8) loss of spinal fluid should be guarded against; (9) the mortality should be less than 1 in 1,000; (10) spinal anesthesia is most valuable for operations below the diaphragm, but should be used with discrimination and for special reasons.

CHAMBERS, Syracuse, N. Y.

RODLESS RETINA, AN OPHTHALMIC MUTATION IN THE HOUSE MOUSE, MUS MUSCULUS. CLYDE E. KEELER, J. Exper. Zool. **46**:355 (Jan. 5) 1927.

A hereditary defect of the eye in a laboratory strain of albino mice consists in a complete absence of the light-sensitive outer layer of the normal retina (layer of rods), and in a great reduction in the number of rows of nuclei in the adjacent external nuclear layer. The normal eye has from ten to fifteen rows of nuclei in the external nuclear layer. Three types may be recognized in the abnormal eyes. The commonest has one row of nuclei in the external nuclear layer and is entirely devoid of rods. Three-row and six-row types are also found, and it is not certain that these are entirely devoid of rods, nor that they are sightless. The latter two types do not

breed true, but fluctuate toward the original one-row condition. They are probably genetic modifications of that type. Rodlessness conforms with every test for a simple recessive mendelian character, without indication of sex linkage or sex limitation. It shows no genetic linkage with any other known mendelian character of mice.

By a variety of tests it has been shown that mice with rodless retinas of the one-row type cannot see. The lack of difference in the behavior of rodless and normal mice in certain tests indicates that vision is a dull sense in the normal mouse. Hearing, smell, and tactile senses are substituted for sight in the rodless animals. The vibrissae are important organs in this respect. Pregnancy greatly increases nervousness under the conditions of the tests.

WYMAN, Boston.

DIVISION OF SENSORY ROOT ON BOTH SIDES: FIRST EXPERIENCE IN A SERIES OF 432 RADICAL OPERATIONS FOR MAJOR TRIGEMINAL NEURALGIA. C. H. FRAZIER, J. A. M. A. **87**:1730 (Nov. 20) 1926.

Frazier considers the history of plans for the relief of tic douloureux, mentioning resection of the gasserian ganglion which was superseded by section of the sensory root as suggested by Spiller in 1901. Furthermore, the hazard of radical operations has been practically removed. In 1894, resection of the gasserian ganglion was attended by a mortality of 22 per cent. In the series of 432 cases under discussion, the mortality has been less than 1 per cent. In 1915, subtotal replaced total section of the sensory root, and in 1919 it was found that the motor root need not be sacrificed.

Bilateral trigeminal neuralgia is fortunately rare, and the surgeon has dreaded what might happen if he had to perform a bilateral operation. He visualized a trophic keratitis of both eyes. Subtotal resection and conservation of the motor root have removed the fear of these dreaded complications.

Frazier presents a case in which a left resection was performed without conservation of the motor root, as it was done before this became routine. The patient presented neuralgia on the right side and, refusing alcoholic injections, consented only to a radical operation; this was done, and the motor root was not conserved. She was unable to close her jaws for seven days, but recovered this function.

CHAMBERS, Syracuse, N. Y.

CEREBELLUM WEIGHT AND TOTAL BRAIN WEIGHT. C. U. ARIENS KAPPERS, J. Nerv. & Ment. Dis. **65**:113 (Feb.) 1927.

The difference between the Mongolian and the Dutch brain leads the author to make a survey of the literature on comparative weights and to make observations of his own. The number of cases hitherto examined seems too small to justify any dogmatic statement. He compared the brains of twenty-two Chinese and eight Japanese with twenty-eight Dutch brains. The average weight of the cerebellum in men was 10.37 per cent of the total weight of the brain, and in women 10.42 per cent of the total weight of the brain. Owing to different methods of weighing, the results of two different authors are never exactly the same. In the author's cases the relative cerebellar weight in the Chinese differed so little from the Dutch as to make practically no difference. The brains of the northern Chinese weighed slightly less, and according to Weisbach's figures, Magyars, who are largely a Mongolian race, have the smallest brain weight among Europeans. In the study of the same

ratio of cerebellum to total brain weight in mammals, the author finds that the most important factor is not the size of the body, but the mode of life—especially the peculiar use of the limbs in moving and grasping. Thus, the whale has a larger total brain weight than the elephant, but the latter has a larger cerebellum in proportion. The author believes that light might be shed on the subject by estimating the relation of the weight of the cerebellum to that of body weight and of the spinal cord weight.

HART, Greenwich, Conn.

CHRONIC EPIDEMIC ENCEPHALITIS. P. K. MCCOWAN and J. S. HARRIS, J. Ment. Sc. **73**:300 (Jan.) 1927.

This paper reports work at the Maudsley Hospital on the effect of hyoscine on carbohydrate metabolism. The injection of 1/100 grain (0.00065 Gm.) of scopolamine hydrobromide into a normal person brings depressant effects immediately and remotely. The same dose in encephalitic parkinsonian patients brings the same immediate but widely different remote effects. The drowsy period is shorter and is followed by improvement in the neurologic signs and in mental alertness. The effect of the same dose on the blood sugar curve of normal persons was a general inhibition of both the rise and the fall. In thirteen cases of parkinsonism the effect was depression of blood sugar levels with acceleration of the fall, an approach to the normal with a corresponding clinical benefit. In seven cases of encephalitis without parkinsonism there were results such as followed the injection of scopolamine in the normal person, with no clinical benefit.

Long distance treatment over two years has been tried with benefit and without the development of tolerance. Often 1/100 (0.00065 Gm.) is given hypodermically in the morning with two or three similar doses by mouth during the day. Increase of comfort is obtained with no effect on the course of the disease.

BOND, Philadelphia.

PSEUDOHYPERTROPHIC MUSCULAR PARALYSIS. R. LEWIN, J. A. M. A. **87**:399 (Aug. 7) 1926.

In this preliminary report on a clinical study of thirty-nine cases is presented a description of pseudohypertrophic muscular dystrophy such as one would expect to find in a textbook. Lewin presents Barnes' classification of the myopathies as well as those of Sachs and Naccarati, and believes that the various types may be various manifestations of the same entity and that if there is definite pseudohypertrophy in the lower extremities it is pseudohypertrophic dystrophy. He then considers etiology, age incidence, sex and nationality. He believes muscle metabolism is the most important factor. Under endocrine disorders, Lewin mentions Timme's belief that pineal shadows as shown in roentgenograms are proof of the causative factor. He also considers other endocrine etiology. He then considers pathology, signs and symptoms, differential diagnosis, course, prognosis, and treatment. He recommends for therapy: (1) a diet rich in vitamins; (2) large doses of calcium lactate in milk; (3) epinephrine by hypodermic injection or by hypodermic tablets dissolved under the tongue; (4) physiotherapy and muscle reeducation. In general, the outlook is pessimistic and, as he says, this disease is a "direct challenge to the medical profession."

CHAMBERS, Syracuse, N. Y.

CONTRIBUTION TO THE HISTOPATHOLOGY OF AMYOTROPHIC LATERAL SCLEROSIS. FRANCIS J. WARNER, J. Nerv. & Ment. Dis. **64**:229 (Sept.) 1926.

Schroeder, Hassin and others have shown that, in amyotrophic lateral sclerosis, the entire motor apparatus of the central nervous system, except the nuclei of the ocular nerves, is involved in degeneration. It is probable that the changes in amyotrophic lateral sclerosis, bulbar paralysis and progressive musculature atrophy are essentially of the same character, but differ in intensity in the various areas involved. The author gives the observations in a case of amyotrophic lateral sclerosis, in which there were reactive pia changes and marked degeneration in the cells of the anterior horns of the spinal cord, the motor nuclei of the bulb, and to a less extent in the motor area of the cortex. There were marked degenerative processes in some of the pyramidal tract fibers and lipoidal accumulations in the adventitial spaces of the blood vessels. No inflammatory phenomena were observed. The author believes that, in the case reported, the process started in the motor apparatus of the spinal cord, with a clinical picture of progressive muscular atrophy, and gradually extended upward, involving the motor cells of the medulla and of the motor cortex, causing a secondary degeneration of the pyramidal fibers and ending in a picture of amyotrophic sclerosis. In this case, there was a pronounced spastic condition corresponding to a mild lesion of the cortical motor system.

HART, Greenwich, Conn.

THE MESENCEPHALIC ORIGIN OF THE NERVE FIBERS OF THE NEURAL PORTION OF THE HYPOPHYSIS. ERWIN STENGEL, Arb. a. d. Neurol. Inst. a. d. Wien. Univ. **28**:25 (May) 1926.

In the dog, the ganglion cells of the midbrain are the source of origin of the nerve fibers that reach the posterior lobe of the hypophysis. In the hypophysis itself, no ganglion cells can be found. The hypophysial fibers do not arise from one single nucleus in the midbrain; they arise from several groups of cells, especially from the small, spindle-shaped cells lying mesially on the floor of the third ventricle, and from a group of cells in the most anterior and lateral portion of the tuber cinereum; this last group of cells does not belong to the nucleus designated by most authors as the nucleus supraopticus; the latter is in all probability the site of origin of a number of nerve fibers that can be seen to reach the neurohypophysis. A number of these fibers also originate from a group of cells lying mesially to the tractus opticus. Stengel has no doubt that the midbrain contains other sources of origin for the hypophysial fibers than those described, but unfortunately they cannot be demonstrated.

KESCHNER, New York.

CONTRIBUTION TO THE KNOWLEDGE OF THE FLEXION PARAPLEGIA OF CEREBRAL ORIGIN. L. v. BOGAERT and R. LEY, J. de neurol. et de psychiat. **26**:547 (Nov.) 1926.

The authors describe a flexion paraplegia in a patient showing a pseudobulbar syndrome accompanied by senile dementia. Anatomic examination revealed the presence of subependymal necrosis, more marked on the left side, a lacunar condition of both corpora striata, and a fibrous condition of the right putamen and caudate nucleus. The right pyramidal tract was degenerated throughout. The authors compare their observations with the one of Pierre Marie and Foix, who described the same clinical picture in a case of subependymal gliosis, as well as with the observations of Alajouanine, who studied the cerebral type of flexion paraplegia from both the experimental and the clinical point of view. Alajouanine

was unable, however, to detect to what extent the extrapyramidal system alone could be responsible for this special form of paraplegia. The authors believe that their observations elucidate this point, as in their case the extrapyramidal system was involved on both sides while the pyramidal tract was affected only on the right. The extrapyramidal lesions are then, according to them, the cause of enhanced automatic reflexes which are at the base of paraplegia in flexion.

FERRARO, New York.

THE ETIOLOGY AND TREATMENT OF PERNICIOUS ANEMIA. LEWELLYS F. BARKER, J. A. M. A. **87**:80 (July 10) 1926.

Following a splendid description of the various hypotheses that have been offered as to the etiology of pernicious anemia, the author concludes: 1. Though the causes of pernicious anemia are not yet fully known, clues are being obtained. 2. Due account must be taken of the peculiarities of incidence and distribution of the disease, of the fact that it occurs usually in middle or later life, of the blood picture, of the associated digestive, nervous and endocrine disturbances, of certain special marks in bodily configuration, of the remissions and of the inevitable fatal termination in the present state of knowledge. 3. Evidence favors hereditary predisposition as the main factor and accessory factors such as toxins from bacteria, fungi or animal parasites in the intestinal tract. 4. Conceptions of the pathogenesis are being extended. 5. Treatment, though not curative, is rewarding. Rest, dilute hydrochloric acid, arsenic, blood injections and other measures often offer relief and may produce remissions. Latency may be established by early recognition and treatment of achylia, paresthesias and glossitis.

CHAMBERS, Syracuse, N. Y.

INHERITANCE OF EPILEPSY. W. R. BRAIN, Quart. J. Med. **19**:299 (April) 1926.

The author studied the family history in a series of more than 200 epileptic (idiopathic) patients. He found that epilepsy was present in 28 per cent of the families (epilepsy present in less than 10 per cent of a control series). This family history is more common in the case of women than men. The onset of the epilepsy occurred in the first decade of life in a larger proportion of those having a family history of epilepsy. Infantile convulsions were twice as common in those who later developed true epilepsy when there was a family history of epilepsy. The first born child in these families developed epilepsy twice as often as those born later. The author believes that the history of probable trauma at birth may be the factor in these cases. The history of insanity was no higher among the relatives of epileptic persons than in the general population. While epileptic persons transmitted the disease to about one in twenty of their offspring, the number here considered is too small to draw any definite conclusions in regard to the practical application of the mendelian principles of inheritance. The author concludes that there is a predisposition to the development of epilepsy in about 28 per cent of the cases.

POTTER, Akron, O.

HYPOGLYCEMIA AND RECURRENT VOMITING. EDITORIAL, J. A. M. A. **87**:34 (July 3) 1926.

Hypoglycemia has recently been shown to be a symptom rivaling in some respects its opposite, hyperglycemia, as a manifestation of bodily disorder, causing extreme hunger and a sense of fatigue, and when markedly low.

anxiety, loss of emotional control, tremulousness or a sense of it, pallor or flushing, a sense of heat, chilliness and a profuse sweat. When it is still lower, mental distress, delirium and finally coma, with loss of deep reflexes, are seen.

Josephs has shown that a large proportion of attacks of recurrent vomiting in children are accompanied by hypoglycemia. He says one cannot insist that this is the cause of recurrent vomiting, but he believes that it is the cause of some of the concomitant symptoms. Many explanations have been offered for recurrent vomiting. Hypoglycemia can be regarded with precision instead of uncertainty. It is, at least, a symptom that suggests a definite type of treatment.

CHAMBERS, Syracuse, N. Y.

EPILEPSY: CHEMICAL INVESTIGATIONS OF RATIONAL TREATMENT BY PRODUCTION OF KETOSIS. FRITZ B. TALBOT, KENNETH M. METCALF and MARGARET E. MORIARTY, Am. J. Dis. Child. **33**:218 (Feb.) 1927.

Ketosis may be produced by fasting or by a ketogenic diet. A ketogenic diet is arranged by reducing the amount of carbohydrate in the food and by increasing the amount of fat. In their blood chemistry studies of epileptic children, the authors found that similar chemical changes occurred in treatment by fasting and by ketogenic diet. A marked production of ketones occurred in patients treated by both methods, as evidenced by increased blood acetone concentration and by a marked excretion of acetone bodies in the breath and in the urine. They further found that the alkali reserve was definitely lowered, and that there was a decrease in the blood sugar concentration. The ketosis caused by fasting and by ketogenic diet was associated with a diminution or cessation of attacks. The authors feel that the production of ketosis by diet gives the greatest promise of improvement of any method as yet devised in the treatment of children with epilepsy.

VONDERAHE, Cincinnati.

FRONTAL LOBE CHANGES IN PARKINSONISM. UMBERTO POPPI, Arb. a. d. neurol. Inst. a. d. Wien. Univ. **28**:111 (May) 1926.

In studying the physiology of the striatum, one is confronted with the question as to whether a lesion in a part of this system alone is sufficient to explain the akinesia and rigidity or whether the akinesia is due also to a lesion in other centers. In an attempt to answer this question, Poppi undertook a careful examination of the frontal lobe—of that part which is not purely motor (beginning with Brodmann's area VIII)—in order to determine the possible relationship that this part of the brain may have to akinesia. He examined six cases of akinetic-hypertonic encephalitis; in most of these, changes, predominately meningeal in nature, were found in the frontal lobes, especially in areas IX, X and XI. The fact, however, that in some cases the changes were definite and marked, while in others they were barely noticeable, would seem to be against the theory that the frontal lobes, at least as far as their extramotorial components are concerned, play any particular rôle in the mechanism of the akinetic-hypertonic syndrome.

KESCHNER, New York.

NONSPECIFIC PROTEIN THERAPY IN GENERAL PARALYSIS. M. M. KUNDE, G. W. HALL and F. G. GERTY, J. A. M. A. **87**:1376 (Oct. 23) 1926.

The authors report a series of twelve patients who have received thirteen intravenous injections of foreign proteins in sufficient amount to produce a chill and fever resembling the malarial paroxysm. The chill, which lasts from five

to thirty minutes, occurs from one-half to two hours after the injection. The maximum temperature is reached four hours after the injection and ranges from 102 to 104 F. Initial leukopenia was found to be succeeded by leukocytosis, which in some cases reached 30,000 in from six to eight hours after the injection. There was sufficient clinical improvement to warrant this report. The authors report the following advantages of the method: (1) chills can be produced at will; (2) temperature can be controlled by regulation of doses; (3) the leukocytosis (not present in malarial inoculation) may be of advantage, and (4) the patient is not inoculated with a disease-producing organism. They believe the method of equal value to malarial inoculation.

CHAMBERS, Syracuse, N. Y.

THE INDUCTION OF PRECOCIOUS SEXUAL MATURITY BY PITUITARY HOMOTRANSPLANTS. P. E. SMITH, Am. J. Physiol. **80**:114 (March) 1927.

Smith's studies were carried out on a large and carefully controlled series of immature female rats. Transplants of pituitary tissue taken indifferently from adult male and female rats were made daily into the muscle of the leg of these animals. The author's criteria for sexual maturity (puberty) were complete establishment of the vaginal canal, uterine hyperemia, oestral accumulation of fluid and the formation of large follicles or of corpora lutea. In all normal animals treated by transplant a striking acceleration in sex maturation was noted. Subjects in which treatment was begun at the age of 10 days became sexually mature in from eight to ten days, and in five or six days when the transplants were begun at the age of weaning, 22 days. In oophorectomized rats transplants exerted no effect. As might have been expected, in hypophysectomized prepubertal animals, a definite delay in sex development occurred, which it was found could be corrected by transplant treatment. According to the author, the gonad stimulating effect described is entirely a function of the anterior lobe, the posterior portion seemingly being entirely inert in this respect.

RAPHAEL, Ann Arbor, Mich.

THE HEMOLYTIC CONSTITUTION. EDITORIAL, J. A. M. A. **86**:1553 (May 15) 1926.

This editorial is concerned with Gänsslen's work on the hemolytic constitution, which is characterized by congenital increased blood destruction, and is manifested in fully developed cases by anemia, icterus and splenic enlargement. A brief description of the clinical signs and symptoms follows; attention is called to Gänsslen's statement that all types from the fully developed to the symptomless case discovered only by examination of the blood, are seen. Other congenital anomalies are frequently seen with this hemolytic constitution such as anomalies of the skull, polydactylia, microphthalmia, epicanthus, amblyopia, deformities of the ear and congenital lesions of the heart. Splenectomy should be performed in advanced cases, but there is evidence that early deaths are rather frequent among persons with hemolytic icterus. The fact that the icterus sometimes recurs after removal of the spleen furnishes evidence that the condition is primarily a disease of the blood cells.

CHAMBERS, Syracuse, N. Y.

TIME OF ADAPTATION OF THE FEEBLEMINDED TO A NEW SURROUNDING. ITS MEASURE AND ITS SIGNIFICANCE. E. DE GRIEFF, J. neurol. et psychiat. **26**:476 (Oct.) 1926.

The author studies the result of the heterofamilial placement of feebleminded children from the special standpoint of the time of adaptation to the new surroundings. The conclusion reached enables him to state that a rapid adapta-

tion to the new surroundings is an unfavorable sign. One year at least should elapse before any definite evaluation can be expressed. The family also needs an average of a year in order to assimilate the child. This is why attempts should be made to persuade the family to keep the patient for at least this length of time. The best period of life for trying the adaptation in a new surrounding is the period preceding puberty, and not later than the early period of this stage. Possibly winter has a favorable influence on the rapidity of adaptation.

FERRARO, New York.

DIGESTION AND MENTAL DISEASES. J. BOSTOCK, M. J. Australia **1**:510 (May) 1926.

The author studied the effect of 100 gastric meals in eighty-four psychotic patients, using the fractional method of Rehfuss. In the cases of mania and states of excitement, the curves differed only slightly from what is regarded as normal. In the remaining cases, there was definite lowering of the curve, both for free hydrochloric acid and total acidity. Based on this clinical work, the author experimented with rabbits. He concludes that achlorhydria and hypochlorhydria are frequent in psychotic cases and believes that these are not causal but merely depression of the general psychophysical reaction. From the work with rabbits, evidence was deduced concerning the possibility of an intimate functional connection between the vagus nucleus, the thyroid gland, and digestion. Achlorhydria is relatively more common in rabbits in which the thyroid had been removed than in control animals.

POTTER, Akron, O.

POSTENCEPHALITIC SEQUELAE OF THE CEREBELLAR ATROPHY TYPE. R. DELBEKE and L. VAN BOGAERT, J. neurol. et psychiat. **26**:411 (July) 1926.

The authors describe a case of postencephalitic syndrome showing the features of cerebellar atrophy. The main symptoms were as follows: (1) disturbances of equilibrium, astasia-abasia, which were more pronounced than the disturbances of coordination; (2) asynergic signs, which were predominant; (3) symmetry of the disturbances, which were more marked in the lower extremities; (4) dysarthric changes of a special type (speech slow and with a guttural intonation). Intentional tremors or nystagmus were not elicited—the postural reflexes, however, were increased rather than diminished as is generally the case with lesions of the cerebellar tracts. The authors compare their case with those of olivopontocerebellar atrophy described by Dejerine and Thomas.

FERRARO, New York.

TREATMENT OF INFANTILE TETANY WITH A PARATHYROID EXTRACT. REPORT OF FOUR CASES. LYNNE A. HOAG and HELEN RIVKIN, J. A. M. A. **86**:1343 (May 1) 1926.

An effort to determine the dosage of parathyroid extract effective for the alleviation and cure of infantile tetany was made by the authors. Parathyroid extract (Collip) was given subcutaneously. The cases were followed clinically and by estimation of the serum calcium concentration. Four cases are reported with the following results: in three, recovery was complete; one patient died of a complicating bronchopneumonia. The authors conclude that a safe tentative dose is 5 units of parathyroid extract per kilogram of body weight for each desired rise of 1 mg. of serum calcium, the total amount to be distributed over a period of from twenty-four to thirty-six hours at from four to six hour intervals.

CHAMBERS, Syracuse, N. Y.

DISORDERS OF RESPIRATION IN DEMENTIA PRAECOX. ROGER MIGNOT and ANDRÉ LE GRAND, Presse méd. **34**:1474 (Nov. 24) 1926.

Several respiratory tracings are reproduced, taken from cases of dementia praecox of different types. They illustrate the following symptoms claimed to be present in schizophrenic patients who exhibit disorders of phonation: (1) Reduced frequency of respiration, from the normal of 18 times a minute, to 15, 12 or even 8. (2) Increased length of the expiratory phase, from the normal ratio of inspiration to expiration as 10:14, to 10:20 and even to the extreme of 10:80. Prolonged expiration is attributed to an "expiratory pause," which has been demonstrated to last as long as seven seconds in some cases. (3) Reduced amplitude of respiration. Respiratory and phonetic disorders in dementia praecox are ascribed to a lowered vagus excitability.

HUDDLESON, New York.

CEREBRAL BIRTH PARALYSIS. T. C. HEMPELMANN, Am. J. Dis. Child. **33**:296 (Feb.) 1927.

The author analyzes 238 cases of cerebral birth paralysis, with especial reference to prognosis and treatment. He finds that the following symptoms, in the order of their importance, indicate a relatively bad prognosis: (*a*) mental deficiency, (*b*) progression of the disease, (*c*) athetosis and (*d*) ataxia. The most successful treatment was found to be peripheral neurectomy of the nerves of supply to the spastic muscles, followed by carefully supervised training to restore the proper balance between the opposed muscle groups.

VONDERAHE, Cincinnati.

PHASES OF NEUROSYPHILIS. ABRAHAM MYERSON and MORRIS YORSHIS, Am. J. Syph. **10**:410, 1926.

Brief clinical and laboratory reports are presented on seventeen cases of neurosyphilis with symptoms less generally understood by non-neurologic medical men than are the classic forms of tabes and general paralysis. Several points are made, among them the following: Neurosyphilis occurs early in the infection, often almost from the outset. These cases are mainly mesodermic involvements, yielding fairly readily to antisyphilitic therapy. The blood Wassermann test has no certain relation to nerve infection, and study of the spinal fluid is essential. Anterior horn involvement in syphilis is rare and may be coincidental. Syphilis and hypertension are more often associated than is generally believed to be the case.

ANDERSON, Philadelphia.

SYMPATHETIC RAMISECTION FOR THE RELIEF OF SPASTICITY. EDITORIAL, J. A. M. A. **87**:851 (Sept. 11) 1926.

The work of Royle and Hunter brings up the questions whether there is a physiologic basis for ramisectomy and whether the operation is successful. Recent scientific contributions, both clinical and experimental, have tended to oppose diametrically the views of Royle and Hunter. The accuracy of Kulschitsky's histologic evidence and Langellan's theory of muscle tone have also come up for scrutiny. Only further carefully controlled scientific experimental and clinical observations promise aid in support of the theoretic and practical aspects of the subject.

CHAMBERS, Syracuse, N. Y.

Pseudorabies in Man; Diagnosis and Treatment. Démètre Jonnesco, Presse méd. **34**:1397 (Nov. 6) 1926.

Two cases of this condition are reported, which at first simulated an infective-exhaustive psychosis, but which were later correctly diagnosed as hysteria, and for which the patients were successfully treated. The reporter calls particular attention to the sudden onset, zones of hypesthesia and hyperesthesia, and especially a state of catatonic negativism followed by crises of paroxysmal excitement with contractures. Mutism, unknown in genuine rabies, was also noted in one of these cases. Several cases of so-called rabies in the literature are rediagnosed as pseudorabies.

Huddleson, New York.

Sporadic Meningococcus Meningitis: Sequelae Following Specific Serum Therapy in Infancy and Early Childhood. S. McLean and J. P. Caffey, J. A. M. A. **87**:91 (July 10) 1926.

The authors report a series of forty-four infants with sporadic meningococcus meningitis treated with antimeningococcus serum and observed for from one to ten years after the treatment. Nine developed serious sequelae: four cases of deaf-mutism, two cases of hydrocephalus, two cases of visual impairment and one case of mental deficiency. Five patients died during the period of observation; thirty are alive and normal. Eleven patients had cisternal and ventricular injections of serum because of subarachnoid block; eight of these made a complete recovery.

Chambers, Syracuse, N. Y.

Tropisms of Mammals. W. J. Crozier and G. Pincus, Proc. Nat. Acad. Sc. U. S. A. **12**:612 (Oct.) 1926.

This is an epitome of a series of experiments in young mammals in which tropisms have been carefully studied. The authors emphasize the importance of using these methods of response, not only in the lower but in all forms, for "direct and precise analysis of the elementary functions of the central nervous system." In their heliotropism, geotropism and stereotropism these experimental mammals (rats and mice) showed responses that are as predictable mathematically as those seen in the study of arthropods. This opens another avenue of approach in the analysis of behavior, which is less cumbersome than the learning tests, less limited than the "interpretation in terms of reflexes" and permits of quantitative control of all experimental elements.

Wolff, Boston.

Actinobacillus Meningitis. Linton Gerdine and Dorothy Pease, Am. J. Dis. Child. **32**:878 (Dec.) 1926.

The patient was a boy, aged 11 months, whose illness began with a "cold" and slight cough; subsequently, symptoms of meningitis developed, and death occurred fifteen days after the onset. The spinal fluid presented a turbid appearance and, on standing, developed threads of a dense clot; microscopic examination showed a large excess of polymorphonuclear leukocytes. The paper contains an extensive bacteriologic report on the organism found in the spinal fluid which appears to have been the actinobacillus first described by Lignières and Spitz. The organisms cause primarily an infection in cattle; only one other case of human infection has been reported.

Vonderahe, Cincinnati.

ABNORMAL BACTERIA FLAGELLA IN CULTURES: THEIR RESEMBLANCE TO SPIROCHETES. HIDEYO NOGUCHI, J. A. M. A. **86**:1340 (May 1) 1926.

The author states that, besides the leptospira-like filaments probably originating from red blood corpuscles under certain conditions in vitro, other spinal elements exist which may be interpreted erroneously as spirochetes. These are the exaggerated detached flagella of certain bacteria produced under cultural conditions. He is of the opinion that the great resemblance existing between the flagella of motile bacteria and the flagella and axial spiral apparatus of certain spirochetes indicates that the axial filaments are probably a modified apparatus of similar origin especially adapted to locomotion of spirochetes and therefore supports the hypothesis of a close phylogenic relationship between bacteria and spirochetes.

CHAMBERS, Syracuse, N. Y.

PURPURA FULMINANS DUE TO THE MENINGOCOCCUS. SINCLAIR BATTLEY, Am. J. Dis. Child. **33**:244 (Feb.) 1927.

The case reported here is that of a boy, aged 10 months, who became suddenly ill, and who had a temperature of 104 F. and a respiratory rate of 52. Bluish-red blotches, obviously hemorrhagic in character, appeared in the skin at various points within about twelve hours. The child died within twenty-four hours of the onset of the illness. A blood culture taken two hours before death showed a growth of meningococcus.

VONDERAHE, Cincinnati.

THE TREATMENT OF GENERAL PARALYSIS BY FEVER-PRODUCING METHODS. EDITORIAL, J. A. M. A. **87**:1394 (Oct. 23) 1926.

In this editorial brief comment is made concerning the malarial inoculation method of Von Jauregg, with its beneficial results and disadvantages. The work of Solomon and others in Boston with the spirochete of morsusmuris is also considered, and mention is made of the work of Kunde, Hall and Gerty on the treatment of general paralysis by the intravenous injection of nonspecific foreign proteins.

CHAMBERS, Syracuse, N. Y.

FIRST SYMPTOMS OF NEUROSYPHILIS. C. S. BLUEMEL, Am. J. Syph. **10**:421, 1926.

One hundred brief histories of neurosyphilitic patients are given to determine the first symptom in each case. These are divided as follows: weakness or pain in legs, 22; strokes and spells, 18; numbness and tingling, 13; mental symptoms, 12; eye symptoms, 9; abdominal symptoms, 8; cranial nerve symptoms, 7; chest pains, epilepsy and bladder disturbances, 3 each; weakness, 2.

ANDERSON, Philadelphia.

STUDIES ON THE OXIDATION AND REDUCTION OF IMMUNOLOGICAL SUBSTANCES. III. TETANOLYSIN. JAMES M. NEILL, J. Exper. Med. **44**:227, 1926.

Two toxins are formed by the tetanus bacillus. The one that is best known is the true killing toxin; the other, the hemotoxin or lysin, is the subject of this paper. It is studied from the point of view of its formation in various culture media, its lability to heat, inactivation, reactivation and oxidation. It appears not to have any activation when the culture fluids are exposed to the air.

COBB, Boston.

FAMILIAL INCIDENCE OF PERONEAL TYPE OF PROGRESSIVE ATROPHY. L. MERVISH, M. Rec. **23**:411 (Sept. 26) 1925.

The author reports three cases of progressive muscular atrophy, seen personally, in one family. A younger brother who was not seen was suspected of having the disease. The onset in each case was at the age of 14 with lameness and swelling in the legs, followed by stiffness and atrophy of the muscles. In addition to the usual symptoms of muscular atrophy, there were areas of dissociated sensation which is unusual in this type of atrophy.

POTTER, Akron, O.

ENDEMIC GOITER AND INTELLIGENCE. CURRENT COMMENT, J. A. M. A. **87**:36 (July 3) 1926.

Observations recently made in the Cincinnati public schools failed to show significant variation in the intelligence of children with a normal thyroid gland and those with enlarged thyroid. Similar investigations in other parts of the country on a more extensive scale must be undertaken before a conclusion can be reached.

CHAMBERS, Syracuse, N. Y.

THE BASAL METABOLISM IN BERIBERI. S. OKADA and E. SAKURAI, Arch. Int. Med. **38**:770 (Dec.) 1926.

Determination of the basal metabolism in a series of forty-seven men between 15 and 29 years of age was made, with the conclusion that normal values are found in uncomplicated cases of beriberi. With marked paralysis and atrophy, a consistent diminution in metabolic rate is observed; in cases with cardiac involvement an increase resulted.

ANDERSON, Philadelphia.

DISPLACEMENT OF THE PINEAL GLAND IN HEAD INJURY. H. G. MEHRTENS and R. R. NEWELL, J. Neurol. & Psychopath. **6**:198 (Nov.) 1925.

In a case of fractured skull, the calcified pineal gland was found displaced. It returned to the midline as the patient recovered from his symptoms of injury to the brain. The authors conclude that the displacement of a calcified pineal gland may disclose the site of contusion of the brain before other localizing signs appear.

FAVILL, Chicago.

FRAGILITAS OSSIUM AND DEAFNESS. J. J. SHUGRUE, R. ROCKWOOD and E. W. ANDERSON, Arch. Int. Med. **39**:98 (Jan.) 1927.

Four cases of blue sclerotics are described, which were associated with brittle bones and, in two cases with deafness. Only one of the cases was definitely hereditary. The author suggests that the most likely explanation is a congenital defect in the mesenchymal tissue, but he admits that this is far from satisfactory.

ANDERSON, Philadelphia.

Society Transactions

PHILADELPHIA NEUROLOGICAL SOCIETY

Regular Meeting, Feb. 25, 1927

M. A. BURNS, M.D., *President, in the Chair*

REPORT OF A CASE OF SUCCESSFUL EXTIRPATION OF MENINGIOMA. DR. FRANCIS C. GRANT.

Left frontotemporal meningioma. Removal of tumor in two operative stages. Recovery.

G. C. F., an American mechanic, aged 31, referred by Dr. William G. Spiller, was admitted to the neurosurgical service of Dr. Charles H. Frazier at the University Hospital on Oct. 4, 1926. About ten weeks prior to presentation the patient began to complain of severe intermittent headache in the frontal and left temporal regions. About the same time he began to have difficulty in expressing himself; he knew what he wished to say but was unable to put it into words. Within a month of the onset of the headache and the difficulty of speech, he found himself becoming unable to read. His wife said that he understands the contents of what is read to him. Four weeks before presentation vomiting commenced and has persisted with increasing severity. For the past two weeks increasing weakness of the right hand and arm has been noted, which has also involved the right leg to some extent. There has been no sensory disturbance on the right side. For the past week the patient has been unable to write his name well. He may write a few letters and then be unable to finish the word. During the vomiting spells he has been noticeably drowsy. During the early weeks of the illness the face became drawn toward the left side, and the tongue tended to get between the teeth on the right side. Saliva drooled from the right corner of the mouth. The past medical, family and social histories were unessential.

Examination.—On admission the patient was well developed, keen and cooperative. He apparently understood what was said to him and obeyed a complicated command correctly. He could not carry on a conversation, although he was at times able to speak a few words correctly. Externally the head was normal, there being no exostoses or points of tenderness. The positive neurologic symptoms, other than the speech defect were: weakness of the right side of the face, in shrugging the right shoulder and in protrusion of the tongue, which deviated to the right; definite weakness in the right arm and leg, especially in the arm and hand; ataxia in the right arm and leg; definite increase in all reflexes on the right side with a Babinski sign and an ankle clonus; no sensory loss, astereognosis, apraxia, anosmia or loss of vibratory sense were demonstrable on the right side.

Dr. Spiller noted, Sept. 21, 1926: "He has great difficulty in finding the word he wants to use and shows much agrammatism, leaving out the conjunctions. This is often the first sign of a beginning word deafness. The words that he uses are usually correct but he has a great paucity of speech. He understands what is said to him and usually will obey a complicated command but on some occasions he cannot accomplish this, showing a partial

word deafness. He reads correctly, picking out the words one by one. He says that he was formerly a fluent speaker. Unquestionably, his temporal lobe symptoms vary from day to day. The distinct sensory aphasia, the agraphia with at times slight word deafness and alexia, together with the right sided hemiparesis and exaggeration of the tendon reflexes on the right, are indicative of a tumor of the left temporal lobe. The absence of right hemianesthesia and of right lateral hemianopia suggest that the tumor does not extend far into the brain substance."

Roentgen-ray examination revealed a suspicious rarefaction in the left temporoparietal region with slight atrophy of the dorsum sellae. The retinoscopic examination showed choking of 1 diopter in each eye; the visual fields were concentrically contracted to a slight degree.

Diagnosis.—It was agreed at a conference that the tumor lay in the temporal lobe and that the exposure should be made so that the anterior limb of the incision included the rolandic area, but not more anteriorly. The center of the flap should be over the temporal and parietal regions behind the motor cortex. From the history, neurologic symptoms suggesting a cortical tumor and the roentgen-ray evidence the tumor was probably an endothelioma. The staff of the neurological service, however, considered the aphasia to be distinctly motor and not sensory. In the absence of symptoms of the parietal lobe, it seemed more probable to them that the tumor lay in front of, rather than behind, the motor cortex. There were myotonic reactions to the blow of the percussion hammer in the muscles of the thenar and hypothenar eminences and in the tongue. This reaction was not found in the other muscles. The electrical reactions of many of the muscles were normal to faradism and galvanism. The ulnar nerves were not hypersensitive to electricity. Myotonia was produced in the muscles of the thenar and hypothenar eminences by rather strong currents. This myotonia in the muscles of the hand could also be produced by a strong current applied to the muscles of the forearm. The abdominal reflexes were absent; the cremasteric reflexes were vermicular. I noted no atrophy of the testes. The patient said that he was not impotent. He has no cataract. The Wassermann reaction of the blood was negative.

This is a case of myotonic dystrophy, a condition first described by Déléage in 1890. The disease was first elevated to an independent cardinal position by Curschman in 1912. Adie and Greenfield added a comprehensive article to the subject in 1923, in which year about 200 cases had been reported with six necropsies. Most of these cases are familial. The nonfamilial occurrence of the disease has, however, been noted, as well as "dystrophia myotonia sine myotonia."

A Case of Myotonic Dystrophy and a Case of Meningioma. Dr. M. K. Meyers.

Case 1.—A man, American-born, of Scandinavian ancestry, aged 32, a seafarer, among whose relatives, so far as he knows, there has been no condition like his own, gave no history of syphilis or bad habits except that he smoked rather excessively. His early history was immaterial, except that he had influenza in 1918 while in the navy. Five years later, he began to develop weakness in the hand grips and weakness and awkwardness in the use of the hands and arms. There was some weakness in walking. He had lost weight.

The patient was tall and thin. There was wasting of some of the muscles of expression and apparently wasting of the masseters, so that a "myopathic

facies" was presented. The tongue was somewhat wasted, and there was marked wasting of the sternocleidomastoids. Marked wasting had occurred in the triceps and biceps of the arms, and in the supinatores longi and other muscles of the forearms. There was no apparent wasting of the muscles of the hand, but when he closed the hands, he had difficulty in opening them; he was able to open them half way relatively easily, but the remainder of the movement was accomplished with difficulty. There was especial difficulty in abducting the thumb. The biceps and triceps reflexes were absent. Marked atrophy occurred in the quadriceps femoris on each side. The knee jerks were just present. There was weakness in flexing each ankle. There were no fibrillary twitchings

First Operation, Oct. 5, 1926.—Under local anesthesia the area of the cortex designated by the neurological service over the temporal and parietal lobes was exposed on the left side. There was no excessive bleeding at this stage except for the bone at the anterior edge of the flap. The inner surface of the bone flap appeared normal. Palpation of the dura gave negative results, although it was tense from increased intracranial pressure. A needle was passed in the direction of the lateral ventricle to relieve the tension. A cyst containing about 20 cc. of yellow, rapidly clotting fluid was encountered at a depth of 2 cm. from the surface. I suspected that I had entered a gliomatous cyst. As this maneuver relieved the tension, the dura was widely opened. In the anterior lower angle of the wound a firm, reddish tumor, adherent to the dura and discrete from the brain, was exposed. As it extended well beyond and below the anterior edge of the opening, and as attempts to remove the bone over it to work around its dural attachments produced severe bleeding which I did not have sufficient muscle to control properly, it was decided to stop the operation at this point. The bone flap was removed because its inner surface was slightly roughened and seemed to have been involved by the tumor. The skin flap was then closed. Recovery was uneventful.

Second Operation, Oct. 18, 1926.—Since it was evident that the growth was vascular, the external carotid artery was first ligated. The old incision was reopened. A further incision was made anteriorly to expose the tumor effectively. Little hemorrhage accompanied the reflection of the flap, but when the tumor was attacked, it proved to have many vascular attachments connecting with the cortex. The bleeding was controlled by muscle grafts and silver clips and total extirpation of the tumor with its dural attachment was accomplished. The tumor had in no area invaded the brain substance; it lay in front of the fissure of rolando, low down over the first frontal convolution. After careful hemostasis the wound was closed.

Course.—Recovery was uneventful. In the two weeks following the operation the patient had several slight convulsive seizures lasting less than a minute and involving only the right side of the face. Consciousness was not lost. At the time of discharge, on Nov. 13, 1926, he had no difficulty of speech except a slight slowness without any aphasia; he had almost completely recovered the power of the right arm and hand and the gait was normal. The cranial defect was soft and flat.

Microscopic examination of the tumor revealed the typical picture of a meningioma.

Comment.—This case illustrates the difficulty which may be encountered in determining the type of an aphasia. Because the defect in speech was not accompanied by other symptoms referable to the parietal lobe, it seemed that the aphasia was probably of the motor type and that the neoplasm lay in front

of the fissure of rolando. The cyst tapped at the first operation was probably a collection of cerebrospinal fluid which had been obstructed by the tumor in its passage up over the cortex, and which had collected in the deep sulcus of the sylvian fissure. The pressure downward of this fluid collection may have accounted for the symptoms referable to the left temporal lobe. But the tumor itself was definitely frontal in position and did not directly impinge on the temporal area.

CASE 2.—*Right frontotemporal meningioma. Removal of tumor by single operation. Recovery.*

A. F., a Jewish taxicab driver, aged 27, referred by Dr. Samuel Leopold, was admitted first to the neurological service of Dr. William G. Spiller on Nov. 27, 1926, complaining of occipital headaches which commenced about Sept. 1, 1926. About October 1, vision began to fail. There were no complaints other than headache and failing vision. The past medical, social and family histories were unessential.

Examination.—On admission he was found to be well developed, keen and cooperative. Externally the head was normal, although some slight suboccipital tenderness could be demonstrated. Except for a choked disk, of 6 diopters, with hemorrhages and exudates, the cranial nerves were normal. The visual fields were somewhat contracted concentrically without any suggestion of a quadrant defect. There was no sensory or motor loss or other evidence of cerebral involvement. The cerebellum was also essentially normal, although there was a suggestion of unsteadiness of gait with swaying in the Romberg and tandem positions. The blood count, urinanalysis, serologic tests and roentgen-ray studies all gave negative results.

From the sudden onset, the suboccipital headache and tenderness, the high degree of choking of disks and the vague but suggestive cerebellar signs, it seemed possible that a cerebellar tumor might be present. The surgical opinion was that immediate steps should be taken to relieve the intracranial tension before the optic nerves had become permanently affected. A ventriculogram or ventricular estimation seemed indicated in an attempt to localize the lesion accurately. After dehydration by the use of magnesium sulphate for two weeks, the vague cerebellar signs had disappeared, the headache had become definitely centered about the right temporal region and possibly a beginning left homonymous hemianopia could be demonstrated. The choked disks had not decreased. A tentative diagnosis of a tumor of the right cerebral hemisphere, probably in the parietal region, was hazarded. The patient was transferred for operation. Two important facts developed on a thorough review of the case: (1) The patient said that memory had become less acute than normal since the onset of his symptoms, and (2) a slight but definite weakness in the left face, arm and leg could be demonstrated, with possible exaggeration of the reflexes on this side. While a diagnosis of right frontal tumor seemed fairly evident, I considered a ventricular estimation necessary.

Operation.—On Nov. 29, 1926, an attempt was first made to tap the lateral ventricle on the right under local anesthesia. This was unsuccessful. The left ventricle, however, could be reached. This showed that an asymmetry of the lateral ventricles existed, with the right ventricle apparently completely obstructed. The tumor must lie, therefore, in the right cerebral hemisphere. From the almost negative neurologic symptoms, it seemed probable that the frontal lobe must be involved with pressure backward on the motor cortex. A right frontotemporal flap was, therefore, reflected. Severe hemorrhage from the bone in the midline and from the dura in this region made it evident that

there might be a vascular surface lesion. Muscle for hemostasis was, therefore, removed from the patient's calf. Palpation of the dura revealed a tumor in the upper anterior area of the wound, well in front of the motor cortex. The tumor was discrete from the brain and adherent to the dura. The dural attachment of the tumor was cut, the vascular connections to the cortex clipped and cut, and the tumor delivered without difficulty. There was no bleeding from the bed of the tumor. The tumor was encapsulated and at no point infiltrated the brain. After examination of the bone flap, the anterior half, which seemed involved in the tumor, was removed. When hemostasis had been completely established, the wound was closed.

Course.—Recovery was uneventful except for some spasticity of the left arm and a slight weakness of the left side of the face. On discharge, December 18, there was no measurable choking of either optic disk. The arm was much improved.

Microscopic Examination.—Microscopic examination of the tumor revealed the histologic structure typical of meningioma.

Comment.—This case illustrates the size to which a tumor may grow in a silent area before it produces definite symptoms. In such cases, while delay and dehydration may be indicated, the patient is being subjected to an unnecessary risk of permanent visual damage. Ventricular estimation or a ventriculogram will give such positive evidence as to the position of the tumor with so little risk that one or the other should be attempted as soon as ordinary neurologic and other routine methods have failed to localize the growth. Intelligent use of ventricular estimation in conjunction with the clinical observations will often make the injection of air unnecessary. As in this case, a shrewd guess as to the position of the tumor may be made following bilateral ventricular tap. It is particularly in cerebral hemispheric tumors that the information derived from this procedure is of value in localization.

Tumor of the Right Medulla in Which the Clinical Diagnosis Had Been Tumor of the Right Cerebellum. Dr. Charles W. Burr.

A man, white, a carpenter, aged 37, in June, 1926, began to vomit, became weak and began to lose weight. On Sept. 9, 1926, he went to a general hospital, and while there, an abscess of the right lower jaw developed.

Examination revealed nothing except that the heart was slightly enlarged. He had slight horizontal nystagmus on looking to the left, and obliquely upward on looking up. The blood Wassermann reaction was negative. The eyegrounds were normal. The vomiting continued. After a few weeks he began to have ataxia on the right side, with ataxic difficulty in walking and also falling to the right. On account of the neurologic condition, Dr. Charles Watt had him transferred to my service at the Orthopaedic Hospital and Infirmary for Nervous Diseases. An operation was performed on the abscess of the jaw, from which he recovered quickly. Examination then revealed that he always fell to the right when trying to walk. Both knee jerks were excessive, but there was no ankle clonus and no Babinski sign. There was no palsy or wasting in the right arm or leg. Speech was normal; there was no aphasia or dysarthria and the mental state was good. There was no diplopia. Examination of the eyes revealed pupils equal in size, and reacting normally to light and in accommodation. The ocular movements were full; there was horizontal nystagmus. The eyegrounds were normal. Examination of the ear revealed subnormal vertigo. By the caloric test, there was no response either from the

vestibulo-ocular or vestibulocerebellar tract from the pathway of the vertical canal. The acoustic nerve was not affected. The opinion given by the aurist was: a lesion of the right cerebellar lobe.

About a month later the old symptoms continued, but slight right facial peripheral palsy began and right glossopharyngeal nerve paralysis developed. The voice became hoarse, with paralysis of the right vocal cord. He now began to complain of right frontal headaches (he had never had headaches before). Hiccup began and became severe. All this time the vomiting had continued. The vomiting was never projectile (it was the result of vascular stasis in the liver, caused by the marked chronic myocarditis). There was no disturbance of sensibility on either side of the body, arms or legs, and no inequality of muscle tone. There was some ataxia in the right arm and marked ataxia in the right leg. The eyegrounds at no time presented any optic neuritis. It became necessary to give morphine because of the hiccup. He then became violently delirious. This was caused by the morphine, as the delirium ceased on stopping the use of this drug. He was taken to the Philadelphia General Hospital, where he died on my service.

Autopsy revealed a tumor of the right side of the medulla with secondary involvement of the cerebellum. I was misled in local diagnosis by the fact that the cerebellar symptoms came on first while those indicating involvement of the right side of the medulla came on later.

DISCUSSION

Dr. W. B. Cadwalader: In Dr. Burr's case choked disks had not developed; they do not occur in every case of cerebral tumor.

Dr. N. W. Winkelman: I have had another case with practically the same history; the patient had been seen by a neurologist in Philadelphia who made a diagnosis of encephalitis, and the symptoms were extremely suggestive of encephalitis, but at autopsy, a tumor similar to that in Dr. Burr's case was found.

Another fact of importance is that lesions of the medulla are extremely rare, especially in contrast to lesions of the pons. I have been struck with the susceptibility of the pons, especially of the basis pontis, to lesions of all sorts; this is in direct contrast to what is found in the midbrain and medulla, adjacent areas. The fact that the pons is a recent addition to the nervous system may well account for this.

Dr. Burr: Regarding the matter of which Dr. Winkelman spoke, I think that it is a general law that lesions are more frequent in the newer part of the brain, although I am not competent to speak as an expert. In dealing work of Solomon and others in Boston with the spirochete of morsusmuris is or the more recent the part of the organ the more liable it is to disease, especially to the kind and sort of tumors that the older men believe depend on biologic rests for cause.

Are the Higher Psychic Functions Localized in the Frontal Lobes? Report of a Case in Which an Endothelial Tumor Was Removed from the Left Frontal Lobe. Dr. T. H. Weisenburg.

The following case is reported because a large endothelial tumor, about the size of a tangerine, was successfully removed from the left prefrontal lobe. The diagnosis was not based on the mental symptoms alone, but on an additional history of increase of intracranial pressure and the development

of a right hemiplegia. In spite of the fact that the mental phenomena in this case were marked, I do not believe that the higher psychic centers are localized in the frontal lobes, particularly in the left frontal lobe. Intelligence is the result of the activity of the entire brain, and such mental symptoms as were present in this patient can also be found as the result of tumors in other parts of the brain. A description given by the patient himself of the mental phenomena is most interesting.

A man, aged 62, first seen September, 1926, gave a history of headaches accompanied with nausea and vomiting, disturbance in sight and increasing weakness on the right side for a month prior to the consultation. He had disturbance in speech — difficulty in expressing himself and in appreciating what was told him. There was also a history of disturbance of mentality and loss of memory which had been coming on during the previous year.

Examination showed moderate right hemiplegia, with no Babinski sign, the right arm was hypertonic and was held in what resembled a paralysis agitans position, and there was present in this arm a more or less constant coarse tremor; a choked disk of 2 diopters was also found. A diagnosis of a tumor of the left side of the frontal lobe was made, and Dr. Ashhurst removed an endothelial growth about the size of an orange on December 17, it being entirely in the prefrontal area. The patient has made a complete recovery.

An account of the mental symptoms is interesting. According to the wife, the patient began "slipping" about a year prior to the operation. At that time he complained of tiredness, lack of attention, difficulty in concentration, such as in adding up figures, loss of memory in that he could not remember the details of his work and faulty judgment in that he would do a lot of things that he should not; about three months before the operation, coincident with the weakness in the right side, he began to have difficulty in talking and understanding what was said to him. He had a history of staggering for about two months before the operation, but this point was uncertain.

According to the son, who is a dentist and intelligent, the patient had always been cheerful, but for about a year prior to the operation he had lost his cheerfulness; nothing definite was noticed, however, until about three months before, when he began to have loss of memory for both recent and past events. He would forget the names of places and forget conversations. About this time he showed lack of judgment in his business, which was insurance. He would, for example, collect money, forget it and leave it on the table. About the same time he would occasionally lose himself. At one time he did not know where he was, although he was only a block from his office. There was also a change in character. He became irritable and careless in his dress and in the way he ate, misusing the knife and fork. At one time he dipped his celery in the gravy. These symptoms gradually increased until a week or two before he was examined. He began to have difficulty in talking and expressing himself, and then he became, according to his son, somewhat delusional, i. e., when he was in the living room and saw people talking he thought that they were talking about him and accused people of saying things about him, although at this time he had no hallucinations of hearing or of sight.

The patient said that he had been slipping mentally for about a year. He noticed this first because he took less interest in what he was doing. He always liked duck shooting, but when he went on such an expedition he wished that the ducks would not rise. He took less interest in what was happening to him and was getting duller. He could not remember things; any concentration was a great effort, and he got so that he wished to do less and less and tried to keep

away from work. For about two or three months before the operation, the whole thing became a sort of dream, and he did not appreciate where he was or know what he was doing. Sometimes he enjoyed the dream, sometimes it was disagreeable, and during this time he would eat too much.

He was completely disoriented for a period of about three weeks prior to the operation, and when he was first examined by me he thought he was coming to have a hat fitted. While in the hospital he had no idea where he was, and everything seemd to be somewhat strange. For a few days before the operation he had hallucinations of various sorts, and he thought he had two horses in the room with him all the time. All these symptoms remained with him until about five days after the operation, when they gradualy cleared up. He has been normal ever since.

DISCUSSION

Dr. T. Fay: As Dr. Weisenburg has said, the operative procedure was simple, but the position of the tumor was extremely interesting. Dr. Weisenburg analyzed the symptoms just before the operation and spoke of a syndrome of the frontal lobe. It was evident that the tumor was exactly where he said it was. The tumor itself extended well forward to the frontal pole, as well as high up and between the hemispheres in front of the precentral gyrus.

Dr. C. K. Mills: I have not the slightest doubt, from my experience and from my study of the literature of neurology, that a higher or the highest psychic region is located in the prefrontal portion of the brain; that is not to say that the "mind" is located here, however. The mind resides in all parts of the nervous system. I have seen a number of cases, chiefly of tumor in the prefrontal region, which caused distinct higher psychic symptoms. Patients may show mental disorders from tumors or other lesions in various parts of the brain, but these cases do not prove or disprove anything about a higher psychic region.

The real symptoms of disease of the parietal lobe are well known. The presence of apraxia, to which Dr. Fay refers, does not necessarily locate a lesion in the parietal lobe. There are cases on record of apraxia from tumors or other lesions of the frontal lobes especially when these were bilateral. Apraxia, when the result of one-sided lesions, is most frequent perhaps from parietal disease. We have, in a posterior association region, a concrete memory field which gives mental symptoms, but these are not of the higher psychic sort.

In regard to Dr. Burr's remarks about the impossibility of giving any definition of higher psychic functions, I think he is wrong. It is easy to take the negative in a question of this kind, but there is much evidence in favor of the higher faculties of attention, memory, judgment, reasoning and emotions.

Dr. F. H. Leavitt: Several years ago, in Dr. Burr's service at the Orthopaedic Hospital, Dr. Taylor operated on a boy, about 10 years of age, whose entire left frontal lobe was replaced by a cyst; there was no indication of the lobe. He was operated on because it was thought that he had a tumor, as he had jacksonian epilepsy which involved the right side of the body. This condition followed a fall from a window, in which he landed on the head and received a serious craniocerebral injury when he was 4 years old. The boy's intelligence was that of a normal boy of 10 years. There were no abnormalities of character or intelligence as far as could be determined, despite the fact that there was no left frontal lobe tissue.

Dr. Weisenburg: Particular attention should be directed to the dreamlike state the patient was in for two or three months prior to the operation. During

this period he was hazy about himself and had various delusions and hallucinations. At this time he developed aphasic symptoms. It is obvious that any study of speech disturbance at this time would be valueless, and yet such observations are constantly noted in the literature.

ENCEPHALITIC TORSION SPASM. DR. ROSS H. THOMPSON.

This case of encephalitic parkinsonism is associated with a torsion spasm that simulates spasmodic torticollis. The torsion involved the left trapezius and sternocleidomastoid muscles, twisting the head slowly and frequently to the right concomitantly with the following maneuvers: an extreme gaping opening of the mouth, a deviation of the lower jaw to the right, a torsion or vermicular turning over movement of the tongue to the right and a movement of the soft palate twisting the uvula upward and to the right. The tongue on protrusion was thrown into a coarse, rapid to and fro tremor extending into the soft palate. There was no disturbance of articulation. Bringing the left hand in contact with the face is probably an effort to control the torsion movement. The placing of the index finger in the mouth, I think, is an outgrowth of this tendency.

MULTIPLE HEMORRHAGES AT BIRTH SIMULATING MULTIPLE SCLEROSIS. DR. H. N. PETERSON.

As the title indicates, this patient presented signs which would usually be ascribed to multiple sclerosis but a history extending back to her birth, sixteen years ago, is as follows: She was delivered by instruments after a labor that lasted forty-eight hours. The parents say that it took fifteen minutes to induce her to breathe, and she was partially asphyxiated for an hour or so. During this interval she is said to have had numerous convulsions, but at no time since had such occurred. She began to teethe at 1 year and to talk at 2 years. At 3 years she started to walk, but she shook and fell so much that she discontinued after three weeks. She began again at 5 years of age, and has been walking since. Ever since she began to walk and to take care of herself in such things as feeding, it has been observed that she is clumsy and tremulous. She has had a halting speech which is better now than it used to be and the handwriting is scarcely legible. The intellectual development has not been retarded or abnormal.

At the present time the right pupil is slightly larger than the left. Both are widely dilated and slightly irregular, but they react briskly to light and in accommodation. There is a slow, jerky nystagmus on lateral fixation of the eyes. Speech is staccato, hesitant and monotonous. There is slight tremor of the tongue on continued extension. Power in the limbs is good and equal on the two sides, but the tonus of the lower extremities is slightly increased. The gait is slightly spastic, and she tends to drag the toes of the right foot. She herself has noticed that she wears out the right shoe before the left. There is incoordination of both arms and of the left leg, and there is intention tremor of the extremities, head and trunk, brought on by such acts as writing. There is some unsteadiness in turning around quickly, but no Romberg sign.

The sensation of touch, pain, temperature, position or vibration is not impaired. Stroking the left upper quadrant of the anterior abdominal wall produces a slight reflex response, but this does not occur on stroking the remaining three quadrants. Biceps, triceps, supinator and knee jerks are increased and equal on the two sides. Ankle jerks are increased, and the right is greater than the left. There is at times an unsustained ankle clonus on the

right side, but this is not constant. Stroking the sole of the left foot produces plantar flexion of all toes and then extension of all the toes and foot. Stroking the sole of the right foot produces extension of the big toe, fanning of the others and extension of the foot at the ankle.

There is some pallor of the temporal portion of the right optic disk but otherwise the fundi are normal. Urinalysis and the blood Wassermann test are negative, and roentgen-ray examination of the skull shows no abnormality, except a rather large sella measuring 1 cm. by 0.5 cm. in depth.

DISCUSSION

DR. BURR: This girl came to my clinic at the infirmary for nervous diseases. Today she shows a picture of multiple sclerosis, and the history is a positive indication that the condition has been present since birth.

A CASE OF VOLUNTARY SEPARATE MOVEMENT OF EACH EXTERNAL RECTUS MUSCLE OF THE EYEBALL. DR. W. G. SPILLER.

This article will be published in full in a later issue.

NEW YORK NEUROLOGICAL SOCIETY

Regular Meeting, March 1, 1927

GEORGE H. KIRBY, M.D., *President, in the Chair*

NEOKINESIS: THE CONTRIBUTION OF THE MAMMALS TO THE EVOLUTION OF THE BRAIN. DR. FREDERICK TILNEY.

Many of our most important problems can be answered only by morphology, particularly comparative neurology. This is an interesting theme built up around the searching inquiry — whence came the powers that have made us human? If we understood the process which effected such powers, the fate of mankind would, in a measure, be in human hands. Although we have not yet acquired this understanding, we may perceive the reflection of the process in the nervous system. The transformation from the low type of adaptive reaction—*paleokinesis*—to the ultimate achievements of highly complex *neokinesis*, is recorded in the brain.

Paleokinesis, the ancient mode of motor reaction, is restricted to the lower vertebrates up to mammals. Neokinesis is the mammalian type of reaction. The difference between these two types is striking. In lower vertebrates, reactions are caused by simple combinations of neural influences having almost immediate effects. In the mammal, a latency exists between the receipt of sensory stimuli and the response. This latency permits reflection, deliberation and selection not possible to the lower vertebrates. The mammal can assemble a vast summation of experience developed by his individual training, including many associations inherited from his race and the phyletic ancestry from which that race was derived. This experience enables the mammal to select and act on the behavioral patterns which endow his kind with plasticity of reaction. The plasticity inherent in neokinesis distinguishes this mode of behavior from the more inelastic, rigidly prescribed performances of inframammalian paleokinesis.

The mammal's plasticity of reaction depends on the development of the neopallium, a special part of the brain which does not appear until the level of the mammal is reached in vertebrate organization. The size, weight and convolution of the brain do not denote its efficiencies, for it is the parts that acquire evolutional prominence, rather than the size, which count in the highest development of behavioral capacity. The neopallium, in its differentiation of special areas for different species and various modes of life, has introduced an element of confusion that prevents exact analysis of function. The brain stem, however, offers a satisfactory analysis of progressive development in neokinesis. The medulla oblongata, cerebellum, pons and midbrain, collectively, clearly show this development. For the present discussion four structures were selected — the pyramid, olive, pons and peduncle — to show the progressive advances in neokinesis. Slides of these parts of the brain stem were shown, together with graphic charts, to indicate the remarkable progress made by the primates in developing these parts of the brain. The primate differentiation of the hands and feet was considered the underlying cause of these advances.

DISCUSSION

Dr. Smith Ely Jelliffe: I hardly believe that there can be any discussion of what Dr. Tilney has so completely and amply set forth. Certainly there is no issue to be taken as to the evidence, so vividly sketched, which is necessary to orient one with the general problems of evolution. One or two points touched on interested me greatly. There probably is no question of the importance of morphologic study, not only from the phylogenetic, but also from the ontogenetic, point of view. Dr. Tilney has already said that functional secrets can be read poorly in structural precipitates, and I fully agree with him. He did not tend to convey the idea that only through structure can one read function. In fact, I feel sure that he would agree with me if I should emphasize the opposite, or functional point of view, and argue that structure came to be what it is in response to function. I should like to have had a little more attention paid to the effects of environmental stimuli. Dr. Tilney touched on this, but I gathered that he was more at home in viewing the machine, from within, as independent. The environmental stimuli are the sole sources of energy that contribute to the development of the human machine. There is no better working formula than that energetic formula which states that the human machine, like all other machines, survives longest through its increased capacity to capture, to transform, and to release energy which is found in the environment. In that urge for increased capacity to capture more energy, we therefore get increased structural bits of apparatus that enable it to be transformed; and those bits of apparatus have also more amply permitted the energy to be discharged.

In Bergson's "Descriptive Evolution," he says that "the cerebral mechanism is arranged just so as to thrust back into the unconscious almost the whole of our past, and to allow beyond the threshold only that which will cast light upon the present situation"; in other words, to do the work in hand. At the most, a few superfluous recollections succeed in smuggling themselves through the half open door. These memories, messengers from the unconscious, dimly remind one of what one is dragging behind unawares. As Dr. Tilney told the story of the mammal, *Homo sapiens*, or as Bergson would prefer to call him, *Homo faber*, of his tapping his stick against the ground and the prompt disgorging of the loot that the reptile had more or less completely ingested, I was reminded forcibly of some types of similar reactions on the part of the

disgorging of loot by *Homo sapiens*, by the slight tapping of legislative and other types of stimuli in the environment. Thus, whereas I am willing to agree most heartily with Dr. Tilney concerning delayed reactions and the other criteria which were given as tending to separate man from the reptiles, at the same time I cannot help but emphasize the fact that man reacts almost as promptly as the reptile with those bits of unconscious mnemic inheritance patterns to which Bergson alluded and concerning which Freud has made one all too keenly aware.

Dr. Walter M. Kraus: It is always a pleasure to listen to facts, not theories, and of these, discussion is not possible. We are like puppies, who, if they should happen to notice a turtle wending its way across the road, crowd around to look at it from many points of view. The turtle to me is symbolic of knowledge, it sometimes stops, pulls in its head so that one scarcely knows the direction in which it is going, and it always goes slowly. Each one of us is a different sort of puppy and looks at the turtle from a different point of view. I look at the facts that Dr. Tilney has given us from a somewhat different point of view than he does.

Dr. Tilney has described the development of certain infracortical structures which are concerned with movement. He has emphasized that the increase of these infracortical structures runs roughly parallel with the increase in size of the cortex. Is it not possible that some of the increase of these infracortical structures is for the purpose of taking care of an increased number of new muscles and perhaps an increased volume of old muscles? If, for example, one compares the muscles of the amphibia with those of the mammal, one finds that there are a considerable number of important changes. Since each muscle has sensory end-organs, more muscles would demand more end-organs, more fibers on the afferent side of the central nervous system and more anterior horn cells. As anterior horn cells are added, other cells and neurons in suprasegmental structures to control these anterior horn cells must be added. The number of neurons (fibers) would increase and the cellular nuclei themselves would increase in size. In two closely related animals, one of which has a much greater volume of muscle tissue than the other — though the individual muscles may be nearly the same — there would naturally be more receptor neurons and cells, and corresponding cells in the suprasegmental levels.

There are apparently two types of activity going on: (1) the appearance of structures needed to take care of old muscles in a new way; (2) an increase of structures to take care of new muscles in an old way. It is also apparent that the growth of the cortex is secondary either to the ability to register more stimuli derived from environment or to an increased ability to retain these as memories. In response, the growth of corticofugal pathways naturally increases.

Dr. Tilney has emphasized another point, notably the evolution of the upper extremities and their difference from the lower extremities. This interests me as bearing on my point of view dealing with the level of various arcs for postural patterns. This difference of postural patterns of the leg and arm is manifested in classic hemiplegia, in which the posture of the leg is still determined in the spinal cord, while that of the arm is determined above the mesencephalon. The leg has never evolved a posture in man comparable to that of the prehensile arm. Just because certain monkeys have a prehensile leg it does not in the least follow that one should expect to find such a pattern in man.

DR. ISRAEL STRAUSS: Dr. Tilney has shown the changes in morphology which seem to go with development of function from the lower animals up to man. Whether function induces the morphologic changes or whether these are due to some as yet unknown evolutionary force which then influences function, is a question which has not been determined.

DR. TILNEY: Of course, I am in sympathy with Dr. Jelliffe's view about environment. We all believe that environment has been one of the great decisive influences in the process of evolution. Carl Akeley made a real advance for the study of the environment. Through his efforts, the king of Belgium set aside a large tract of land in the Congo which has been made a gorilla sanctuary, with the idea that the great anthropoid would still have an opportunity to remain on earth and be studied. Akeley's interpretation of the gorilla's behavior and disposition was different from mine. He thought the animal was a timid and gentle creature, that in all probability it would be possible to go into the sanctuary and get some idea of what environment had to do with its particular specialization. Yerkes, Koehler and others are doing this work to see what influence environment has on various determining habits and characters in the primates.

As a whole, this is a profound subject. I would recommend that you listen to Professor Henry Fairfield Osborn on the subject. It would be most enlightening to hear him explain his tetraplastic theory of evolution.

The other point that Dr. Jelliffe makes about the tendency for the neopallium to retain the memory of its entire genesis, its individual experience, its racial experience and its phylogenetic experience, is something I endeavored to bring out in my opening discussion. This retention is not to be doubted. I feel that the individual recapitulates the experience of its race and its phylum.

With reference to Dr. Kraus' contention concerning the influence of increased musculature as having a definite rôle in the development of the brain, and the neopallium particularly, I think it is a fair supposition. I am not prepared to meet this theory now because I think there are certain real criticisms which might be raised against it in studying such closely allied forms as are contained in the primate order. Professor George Huntington, in his noted contribution to the musculature of the primates, states that the variation in muscles is extremely small in this group. When one considers such forms as the cetaceans or other animals which have made secondary adaptation to the water, perhaps one may find the muscles playing a larger rôle in the development of the neopallium. But here the development is largely in the parietal area, and does not enter in any particular way into those cortical constituents and components of the neopallium which count so much in mankind and in the higher vertebrates.

As to the question of neurobiotaxis, this is a confusing field. We cannot go into it now. I do not know, for example, why it is that palliopontile fibers come down to the pons and finally connect with the lateral lobes of the cerebellum. This may be due to a neurobiotactic influence; it may be caused by something else, for further investigations to bring out. It only proves that this field of morphology is by no means exhausted or sterile. In reality it is a most fertile field in the study of neurology. It is the one field in which both feet may be kept on the ground. The problems here proposed are all morphologic, and the answers to them may well bring to a solution some of the more complex psychologic difficulties which are confusing today.

In answer to Dr. Strauss, I am delighted that he feels doubtful, for without doubt science would cease to be of interest. It is the one thing which

makes one desire to go forward. I feel confused because I have lack of knowledge, and doubt is nothing more than the state of mind due to this lack; when one begins to know, then doubt leaves. It behooves one not to be content with existing knowledge, but to make an energetic attempt to acquire more knowledge. We have only begun to scratch the surface of the field of the comparative morphology of the brain. When we come to the great field of invertebrate neurology, we are practically in primeval darkness. Whenever the question of evolution comes up, and I hear of these legitimate and well understood doubts and confusions, it is stimulating rather than otherwise. I have as many doubts as Dr. Strauss; but I have an irresistible desire and ambition to settle as many as I can before I die.

IRRADIATION OF TUMORS OF THE BRAIN. DR. GEORGE H. HYSLOP and DR. MAURICE LENZ.

Our study of the problem of irradiation in tumor of the brain has been directed toward the technical side of treatment and also toward the analysis of the effects of treatment in twenty cases of glioma of the brain verified by operation. Previous reports have been unsatisfactory in many respects. This report should be regarded as preliminary, since the material is relatively small. It has seemed important to correlate clinical results with the mode of therapy used and the dosage administered. To do this required knowledge of the location, size and extent of each tumor. We find that external radiation by either the radium pack or by high voltage roentgen ray is the most efficient form of radiation. We observed that when doses of erythema units or more to the tumor tissue were administered at a given treatment, the patient showed a more definite response. Smaller doses were less likely to be followed by clinical improvement. In giving treatment one must therefore estimate the doses of radiation in relation to the tumor tissue.

Study of clinical material enables us to put forward the following tentative conclusions: (1) Radiation may produce what is called an immediate reaction. This consists of an increased intracranial pressure, both general and focal. It may commence in a few hours after the application of treatment, seldom lasts more than two days, and may be dangerous in certain cases. It has no relation to the appearance of clinical benefit. A reaction can be avoided by administering each course of treatment in fractional doses. (2) One half of the patients were benefited by treatment. This benefit consisted of clinical improvement of a type or degree not observed to occur spontaneously, and not attributable to operation. In some patients who had had several courses of treatment, increase of symptoms preceded, and immediate benefit followed, each treatment. The duration of benefit varied from a few weeks to several months. Seven of the twenty patients had tumors of malignant type. Five of these were benefited by irradiation. The infiltrating tumors were more amenable to irradiation than the cystic tumors, particularly those of the cerebellum. (3) Preoperative irradiation has little justification. Prior to exploration, the pathologic diagnosis is uncertain; and even if a tumor were present, its nature, localization and extent cannot be determined. Furthermore, an immediate reaction to irradiation might prove serious when there is no decompressive opening.

DISCUSSION

DR. DOUGLAS QUICK: Dr. Hyslop and Dr. Lenz have made a careful and timely survey of these cases. Previous reports have been indefinite. Certainly this analysis cannot be criticized from the standpoint of overdrawn optimism.

Though the group is small, the cases show the great inaccuracy of the manner in which patients have been treated, both as to the dosage and its timing. The amount and character of radiation can be improved on considerably. The authors might have spoken a little more fully about the quality of the radiation. The measurements given indicated the quantity of radiation absorbed at a given depth. Applying the knowledge obtained in dealing with neoplastic disease in other locations, it is found that the quality of radiation and the factor of wave length have a great deal to do with the biologic effect. This means that for a given percentage of radiation absorbed, radium has distinct advantages to offer as compared with the same quantity of roentgen-ray radiation. I have had practically no experience in using interstitial radiation, that is, radium buried in containers or seeds, either left in place or taken out afterward. The investigation showed many of the dangers of radiation, and that certain of the major dangers can be avoided in the future. I was glad to hear Dr. Hyslop say something of the histologic basis for deciding or at least predicting something of the effect which may be expected from radiation in a given case, and also its application to the kind of radiation which may be necessary in certain cases. In applying physical agents to any type of neoplastic disease the histologic factor should always be borne in mind.

One other observation which was made is that little or no radiation effect was noted in the postmortem material available for study. That indicates only one thing: that in practically all of these cases too little irradiation was employed as compared with what has been found necessary in treating more accessible tumors and securing the response obtained in them. Localized, accurately placed, interstitial radiation, where applicable, is by far the most efficient means of irradiating any growth. The only man who can do that is the neurosurgeon; until he does this, the best results available from physical agents in treating tumors of the brain will not be secured.

Dr. Strauss: Dr. Hyslop and Dr. Lenz allowed me to read their paper before it was read at this meeting; I was impressed by the care with which they had gone into the work, and particularly with the importance of the work of preliminary investigation. I see no reason for irradiating cystic tumors of the cerebellum. They should be enucleated, especially as many of them are not malignant. The same is true of cystic tumors in the right temporosphenoidal lobe. That leaves the malignant, infiltrating growths in any region of the brain, especially in regions where removal, even if sometimes successful, endangers life and may cripple the patient. It is interesting to know that two or three of the spongioblastomas, which are malignant and consist of a cell of embryonal type that ought to yield to this method, did show considerable improvement, so that I hope further studies in this line will be directed to that type of growth, and that better results may be obtained in a condition which is otherwise hopeless.

Drs. Hyslop and Lenz have described what they can do for certain types of tumor of the brain. What can the neurosurgeon do to facilitate more thorough radiation? Obviously, accurate localization as to depth and extent of the tumor is a most important factor. Unfortunately, this is extremely difficult, since deep tumors may show little difference in structure or appearance from the immediate brain tissue in which they lie. If the tumor is not removable, verification of the tumor by removal of a section or by aspiration of tissue should be made so that the type of cell of the neoplasm may be determined and the prognosis under deep irradiation more accurate.

By leaving a decompression, when this is possible, a greater factor of safety may be provided, since irradiation causes edema and swelling of the tumor bed. Swelling of the tumor bed when enclosed in two rigid walls, such as the dura and the cranial vault, may be dangerous, especially in tumors of the posterior fossa. In this connection I would suggest that hypertonic saline solution or dextrose be given intravenously to diminish edema following irradiation. These should be important and valuable aids in overcoming edema, since they cause marked shrinkage of the bulk of the brain.

Dr. Hyslop has referred to the changes of tumor cells after irradiation in two of his cases. To these I should like to add a third. A medulloblastoma of the fourth ventricle in a child, aged 4, was so extremely vascular that removal was considered impossible, and a decompression was left after removal of a small part of the tumor for verification of the clinical diagnosis of medulloblastoma. Irradiation was employed, and in six months another attempt at removal was made. This time the tumor was entirely taken out with the exception of a small bit which arose from the medulla without any line of demarcation between it and the medulla, so that it was necessary to leave the remnant of the tumor which had invaded the medulla.

The gross appearance of the tumor at the second operation was different from that at the first operation; the color was grayer and less red; it was decidedly less vascular, and consequently most of it could be removed. Dr. Penfield studied the sections both before and after irradiation, and reports a marked difference in the cellular characteristics and in the vascularity of the tumor. Thus irradiation may be of value in changing the character of the tumor and in diminishing its vascular bed so that removal at a second operation after irradiation may become possible, as was the case in this instance. This particular phase of the value of irradiation has not been stressed, and I think it important.

Another point and one of no little value is the psychologic effect of irradiation on the family as well as on the patient. They feel that all hope has not been lost, and that chances of prolongation of life are not completely swept away.

Dr. Michael Osnato: Is the increased intracranial pressure occasionally produced by improper irradiation ever expressed clinically in the experience of the authors by an increase in the swelling of the disk. I have a patient at the Post-Graduate Hospital who developed a rapidly increasing papilledema following roentgen-ray therapy.

Dr. Lenz: I would like to take up two points emphasized by Dr. Quick: the difference in quality between radiation from externally applied radium and high voltage roentgen-ray therapy, and the possibility of using interstitial radiation in gliomas of the brain. I agree with Dr. Quick that experience with irradiation of neoplasms in other parts of the body by large amounts of radium at long focal distances seems to give better clinical results than are obtained by high voltage roentgen rays. Our series, however, is too small to permit judgment on this point; the focal distance of the radium used in our cases was 6 cm., while that of the roentgen-ray tube was 30 cm. or more. A comparison between these two agents is, therefore, not justifiable from the material. I cannot agree with the second point regarding interstitial irradiation. Dr. Quick has had much more experience with interstitial irradiation than I, and is, therefore, in a better position to judge what he can accomplish by this method. However, success with interstitial irradiation depends on the

accurate insertion of the radium-bearing needles throughout the mass of the tumor. This is a difficult problem in the majority of infiltrating gliomas, since the outer limits of the growth cannot be seen at the time of the operation. It seems more rational to attack such a growth by external irradiation, since the likelihood of irradiating the entire tumor is greater.

DR. HYSLOP: Dr. Strauss mentioned irradiation of cystic tumors. We had striking results in three cystic tumors, one being a spongioblastoma. I see no reason for not irradiating this type of neoplasm.

Dr. Stookey referred to the fact that irradiation may be helpful in the eventual removal of a tumor. By giving fractional doses, we obviate the dangers of hyperemia.

Dr. Osnato asked about swelling of the disk during the immediate reaction. We have not seen it in our series, but its occurrence is recorded in the literature.

SOCIÉTÉ DE NEUROLOGIE DE PARIS

March 3, 1927

PROF. G. ROUSSY, *President, in the Chair*

Rev. neurol **1**:329 (March) 1927

THE ORIGIN OF THE CEREBROSPINAL FLUID: MENINGEAL CAPILLARY PERMEABILITY AND THE COMPOSITION OF THIS LIQUID. W. MESTREZAT.

Since 1921, the author has believed with Becht that none of the physiologic arguments given as proof of the secretory activity of the choroid plexus could be maintained. Moreover, the question of origin of this fluid from the pia was directly solved by obstructing the aqueduct of Sylvius and noting that the cerebrospinal fluid remained normal. Following this the author demonstrated the presence of true capillaries in the pia and the immediate contact of these vessels with the liquid in the subarachnoid space. Therefore, he assumes that the cerebrospinal fluid is an example of a normal product of capillaries everywhere throughout the body, and that the identity of the following fluids is dependent on this. The fluids are: cerebrospinal fluid, the aqueous humor, the vitreous humor, white bile, pure edema and the dialysates artificially obtained (he might have added glomerular urine according to Fremont-Smith). Therefore, this type of fluid deserves to be called the original lymph.

The author related experimental proofs to show that the cerebrospinal fluid under satisfactory conditions is really in osmotic equilibrium with the plasma, and that the permeability of the meningeal capillaries from the physiopathologic standpoint gives the key to the chemical modifications of the cerebrospinal fluid in different conditions. It, therefore, rapidly indicates a diagnosis which further investigation will render more precise. The author, experimenting with collodion membranes, dialyzing cerebrospinal fluid against blood plasma removed at the same time, noted that even up to ninety-six hours there was no change at all within the limit of experimental error. The crystalloids in the cerebrospinal fluid remained in higher concentration, whereas albumin was practically absent. By submitting the collodion tubes to degrees of temperature above 100 C., he was able to say that the permeability of the membrane to colloids increased in fairly direct proportion, and that when albumin was found in measurable quantities in

the cerebrospinal fluid within the sac, there was a fall in the sodium chloride and in the dextrose until they were practically equal with those in the blood. "The cause which had maintained or brought about the separation of these two states of matter in solution having disappeared, the chemical disequilibrium became progressively reduced. The cerebrospinal fluid became richer in colloids as it lost its chlorides."

The meningitides harmonize the reactions of chlorides, sugar and albumin. The increase of sugar is in general masked by secondary effects. An interesting fact shows well how closely chlorides and glucose are linked with meningeal vascular permeability. This is the monosymptomatic character of the hyperalbuminoses in pure degenerative lesions of the brain and spinal cord as in certain cases of treated syphilis, or of general paralysis without meningeal reaction.

A table is given illustrating the principal cerebrospinal fluid syndromes.

Idiomuscular Hyperexcitability and the Buttocks Sign, a Symptom of Unilateral Extrapyramidal Disturbance. A. Roquier.

In cases of parkinsonism, idiomuscular excitability is high, and it is a question whether a similar disturbance cannot be found in other cases of extrapyramidal disease. The reaction is brought about by repeated strokes of the hammer and is most easily seen in the region of the buttock. A stiffening can be felt with the fingers. The same reaction can be brought out easily in other muscles, particularly in the trapezius, but it is most common in the glutei. The patient presented no other symptoms of extrapyramidal disturbance than tremor, and showed neither the least hypertonia, exaggeration of the postural reflexes, nor the cogwheel phenomenon; yet the idiomuscular hyperexcitability of one side allowed the determination of the organic origin of the apparently functional disorder present. Some years ago, before these conditions were recognized, this patient would undoubtedly have passed as a pithiatic patient.

Cheyne-Stokes Respiration and Periodic Babinski Sign. Auguste Tournay.

The Babinski sign can appear temporarily in the course of natural sleep of deep character, and in infections, intoxications and autointoxications, particularly those due to serious renal or hepatic insufficiency. Curschmann called attention to this indication of defective cortical inhibition in uremia. In the case presented by the author there was hypertension and serious nephritis tending toward uremia with enlargement of the liver. The Babinski sign varied, depending on the condition of the patient who had a typical Cheyne-Stokes respiration with absolute pauses of from ten to fifteen seconds. During the apneic period the plantar reflex was in extension; while the patient was breathing, the response was in flexion. The theoretic interest attached to this phenomenon in regard to the mechanism of periodic respiration and the relationship of the cerebral cortex to the respiratory center is exceptionally great.

Innervation of Some Muscles of the Face by Both Facial Nerves; Muscular Synergy and Double Innervation in the Human Organism. Dr. Georges Bourguignon.

This study was made on a patient before and after section of the facial nerve and the sympathetic trunk for the relief of facial spasm. Before the operation both nerves were excitable; there was only slight variation in the cronaxia due to previous injections of alcohol. Following the operation there was seen some voluntary contraction in the orbicularis palpebrarum of that side. With the

galvanic current, even with 15 milliampères, there was no movement in the muscles on the right side. The nerve was totally inexcitable. In testing the left facial nerves there were twitches on that side, but in addition a small but lively contraction of the right orbicularis. By moving the electrode slightly off the facial nerve the contraction on the opposite side disappeared. The stimulation of the orbicularis on both sides was obtained all along the course of the superior branch of the facial nerve as far as the motor point of the frontalis. There was no similar contraction from following the same course on the left side, as long as the current was kept below the threshold of direct muscular excitation. Such facts demonstrate that the facial nerve innervates the orbicularis of both sides. A study of the cronaxia verifies these conclusions.

These facts are related to a whole series of others concerning muscles which act in a synergic manner. Synergic muscles are joined not only in the equality of their cronaxia, but also by an anastomosis of their nerves. Thus the brachioradialis receives a small branch of the musculocutaneous. This branch links the brachialis anticus and the brachioradialis, the motor point being over the point of division of the nerve in the interior of the muscle.

In the same way the first and second interossi are joined with the corresponding lumbricals and thus receive filaments, not only from the cubital nerve, but also from the median. In certain cases, at least, the synergy of muscles innervated by different nerves is thus assured as well by the equality of the cronaxia of the two muscles as by a common accessory innervation.

Syndrome of Claude Bernard-Horner in Lesions of the Lower Part of the Spinal Cord. Dr. Conos.

The author reports two more cases in which the oculopupillary syndrome was present with the lesion far down in the thoracic region. In the first instance a child, aged 11, had a spasmodic paraplegia for three years with exaggerated reflexes and lively reflexes of spinal automatism. There was incomplete block with arrest of iodized oil at the eighth thoracic segment. The Horner syndrome was complete. Operation disclosed a fusiform cystic mass at the level of the tenth thoracic segment, and a second operation at the eighth thoracic level disclosed a soft brownish mass compressing the spinal cord. Following the operation there was still narrowing of the palpebral tissue and enophthalmus, but the right pupil was now larger than the left. The patient left the hospital unimproved and with this dissociation still present.

In the second case, a man, aged 65, had a paraplegia of sudden onset with level symptoms at the umbilicus. There was a characteristic oculopupillary syndrome.

Medullary Compression by a Hydatid Cyst of the Vertebral Column. Complete Paraplegia: Operation and Rapid Recovery. Dr. Conos.

The year before examination the patient, aged 36, had severe pains in the loins with a sense of pressure and radiation into the legs. At this time there was also some weakness, and he had to stay in bed. In three months, however, he was apparently as well as ever; but in another six months, he again had pains in the lumbar region, and the lower limbs sometimes became numb and jumped. Examination revealed signs of medullary compression, but it was not confirmed by injection of iodized oil. Antisyphilitic treatment was unavailing. Another injection of oil showed an arrest at the first lumbar spine. Operation disclosed the hydatid cyst between the dura and the vertebral column, having eroded the tenth thoracic vertebra to the left and displaced the cord to the right. This was removed without difficulty and except for slight fever and some retention of urine

the postoperative course was benign. The patient was able to leave the hospital in about two weeks. An examination at this time showed practically no deficit, motor or sensory.

CASE OF EPILEPSY OF THE STUMP. RÔLE OF THE PERIVASCULAR CENTRIPETAL PATHWAYS. REFLEX PHYSIOPATHIC DISORDERS: RELATIONSHIP WITH LATENT TETANUS. DR. J. TINEL.

This extraordinary and complicated case was fully considered. In 1918, at the age of 32, the patient was wounded in the foot and then the leg was carried away. The next day the limb was amputated at the upper third of the leg, and for two years the patient's condition was excellent; he was able to walk with a prosthetic appliance. In 1920, however, following a severe emotional disturbance a series of abscesses developed in the stump and in various parts of the thigh, which continued during the year. At this time there were severe pains in the stump, and finally these spread over the whole course of the sciatic nerve, becoming rapidly intolerable and radiating into the lumbar region and even into the left sciatic distribution. The right thigh became atrophic; the left knee also become somewhat atrophic; gradually epilepsy appeared in the stump, accompanied by a whole series of reflex disorders: muscular hypotonia, sudden giving way of the healthy leg, radiating pains, cutaneous hypesthesia, disturbance of the bladder and rectum and growth of hair. The jerking of the stump was present continually, provoked by contact with the scar or with the thigh, by the carrying of apparatus and even by the weight of the bed clothes. The patient stayed in bed practically for four years, away from light and noise. Operation consisted in resection of the neuromas of the internal and external popliteal and of the internal saphenous nerves. This operation was rendered particularly difficult by the constant twitching of the stump even under deep anesthesia. After operation there was noticeable reduction in the pain in the limb, and for a while the phantom foot became evident, a sensation previously absent for years; on the other hand, radiating pains persisted. There was hyperalgesia of the thigh. On the left side in the same way hyperalgesia had replaced hypesthesia, and there were vesical and rectal spasms with severe pain in the perineal region, particularly during defecation. The epilepsy of the stump had not diminished at all. Two weeks after the operation, a new abscess appeared in the right thigh and after another week tetanus developed. Treatment for this consisted of intraspinal injections of antitoxin and dealbuminated serum and finally by anatoxin by the subcutaneous route. There was marked improvement for twenty-four hours after each injection, but the patient was not considered cured for five or six weeks. Recovery from the tetanus coincided with the disappearance of pains in the thigh, together with marked reduction in the spasmodic condition of the stump. It would seem certain that this acute attack was due to the lighting up of an infection suffered at the time of wounding. History shows that the patient had received antitetanic serum at that time.

At the second operation, in June, 1926, four months after the first, the spasms of the stump yielded easily to anesthesia. At this time the perivascular sheath of the femoral artery was resected for 4 cm. Following this the violent pain which he had had in the right thigh and especially in the scar disappeared, although there were certain deep pains. Still the epilepsy of the stump did not completely disappear. If this epilepsy was due to hyperexcitability of the spinal center, provoked and continued by the painful peripheral stimuli, the periarterial sympathectomy caused the disappearance only of the irritation. These centers, however, must have received stimuli from other sources, for the epilepsy yielded with extreme slowness. In the presence of tetanic infection, it is a question how much this epilepsy

of the stump is favored or exaggerated by the latent tetanus. It is probable that the local impregnation of the nervous system by tetanus would be translated by exaggeration of medullary excitability manifesting itself in epilepsy of the stump in response to painful peripheral stimuli.

Tinel concluded: "1. That painful peripheral stimulation is transmitted to the nervous centers by different pathways and that among these afferent pathways an important part is played by the perivascular sympathetic fibers. Our case therefore confirms Vincent's point. 2. Hyperexcitability of the medullary centers, acquired doubtless by the repetition of painful stimuli, may be persistent and last a long time after the suppression of the pain that gave rise to it. It is manifested not only by epilepsy of the stump but also by a series of reflex disorders such as hypotonia, visceral spasm, vasomotor reactions, trophic and sudorific responses. 3. With these symptoms of stimulation the phenomena of inhibition were noted: hypotonia, giving way of the leg, muscular atrophy, and particularly cutaneous hypesthesia which was measured more or less quantitatively. This is a new contribution to the study made by Babinski and Froment. 4. The appearance of acute tetanus suggests that there was an ancient infection, which, however, seems to have played an important part in the excessive character of medullary hyperexcitability in response to painful peripheral stimuli. Latent tetanus cannot be invoked in every case of epilepsy of the stump, but if it is present, it brings about a condition particularly favorable for the appearance of this condition."

FREEMAN, Washington, D. C.

CHICAGO NEUROLOGICAL SOCIETY

Regular Meeting, March 17, 1927

JOHN FAVILL, M.D., *President, in the Chair*

ACUTE (EPIDEMIC [?]) ENCEPHALITIS: REPORT OF A CASE IN A NEW-BORN TWIN, WITH HISTOLOGIC OBSERVATIONS. DR. G. B. HASSIN.

This article appeared in full in the July, 1927, issue of the ARCHIVES.

DISCUSSION

DR. PETER BASSOE: Dr. Hassin raised the question I had in mind. I think we cannot consider this a proved encephalitis of the epidemic form. It is against everything we know of that disease to have so much polymorphonuclear cell infiltration. On the other hand, the involvement was principally in the usual location, in the basal ganglia and the pons. It is possible that it may have been a cerebral form of poliomyelitis, in which we are more apt to have polymorphonuclear cells early. In the infant Dr. Hassin mentioned there were no polymorphonuclear cells in the infiltration.

DR. WILLIAM H. HOLMES: Did the other viscera, the heart, lungs, liver, spleen and so on, show the presence of polymorphonuclear infiltration?

DR. HASSIN, closing: I realize the difficulty of classifying this case properly, and therefore added a question mark to my title. In the paper I attempted to present the reasons for classifying my case as encephalitis and not poliomyelitis. I was guided mainly by the similarity of my observations with those

of Levaditi and his co-workers in experimental encephalitis, and the work of DeFano on a similar case. However, he also had a question mark added to his title.

In the case recorded jointly with Bassoe, the diagnosis was still more difficult because in that case the spinal cord was also involved. The localization of the cerebral lesions and other factors discussed elsewhere may be of some help.

In reply to Dr. Holmes I may say that only the brain and a small portion of the spinal cord were available for examination (through the kindness of Dr. Lederer).

Two Cases of Abscess of the Brain with an Erroneous Clinical Diagnosis. Dr. Peter Bassoe and Dr. I. B. Diamond.

This paper will be published in full in a later issue.

Early Days and Experiences in Psychiatry 1870-1900. Dr. Richard Dewey.

In 1871, when I became an assistant physician at the State Hospital for the Insane at Elgin, Ill., education in psychiatry was neglected; the medical graduate could complete his course without seeing a case of mental disease. Insanity was a thing apart; anatomy, physiology and pathology, as applied to the psychoses, left a wide gap which had yet to be filled. Research was rife in the older countries, but in our incomplete development the time for it had not arrived. Indeed, criticism of such work as was done was not lacking. In 1874, Westphal described the cuts appearing in the *Journal of Insanity*, July, 1874, to illustrate an article on Pathology of Insanity as "so gut wie gar nichts." The institutions for the insane were not provided with equipment for such studies. The *Journal of Nervous and Mental Diseases* had just begun its career, in Chicago, under the direction of Dr. J. S. Jewell with Dr. H. M. Bannister as an able coadjutor. This journal complained of "too little zeal shown by American alienists" (April, 1878) and feared that "asylums would not bear close scrutiny" (July, 1879).

The standard textbooks at the time were those of Bucknill and Tuke, Maudsley, Griesinger, Esquirol, Isaac Ray on Jurisprudence, Hughlings Jackson, and Krafft Ebing. Classification of the psychoses was on traditional lines, and labels were applied to cases instead of integrating and differentiating them as is done today. Krafft Ebing's description of paranoia did not came until 1879, and Kraepelin's dementia praecox and manic-depressive insanity were far in the future.

Provision for the widely varying forms of mental diseases and defects was in its crudest beginnings. There was no separate provision for the criminal or convict insane, none for epileptics, none for alcoholic cases. The psychopathic hospital had not been heard of. Conditions following the Civil War were such that there was a vast amount of mental disease. During the war nothing had been done to meet the situation; after its close there was an agitation for relief throughout the country, and from that time until the present an intermittent effort has been in progress to endeavor to catch up with the conditions which have been rendered more and more urgent by immigration, natural increase of population and the remarkable fecundity of the feebleminded.

In the early experiences in the care of mental diseases it was found that there was an essential difference between the medical service for mental

diseases and that of the general hospital. The sense of this need led to the development of training schools which began to be established in the early eighties. The first to gain formal organization and recognition was that at McLean Asylum under the leadership of Dr. Edward Cowles. The first class graduated in 1883. The first school in a state institution was started by Dr. W. D. Granger at the Buffalo State Hospital in 1883. In 1886, a school was started at Kankakee and the first class graduated in 1888. A political upheaval, in 1892, led to the dismissal of the medical superintendent, and this training school came for the time being to an untimely end.

In Illinois, in 1869, a Board of Public Charities was created, and two new institutions were established, The Northern Hospital at Elgin and the Southern Hospital at Anna. The secretary of the new board, Mr. Frederick Howard Wines, developed the idea of the so-called "cottage system" for the construction of the buildings, and endeavored to have the system adopted at Elgin and Anna, but without success. The plan was, however, adopted when the construction of a new hospital at Kankakee was approved in 1877. Three such cottages were provided for 100 patients, and it fell to me as medical superintendent to carry out the plan. Experience with these first units was favorable, and the next legislature provided funds for the erection of cottages for 1,000 patients. When I retired from the superintendency, in 1893, the number of patients had increased to 2,000.

I have discussed elsewhere the struggle for the abolition of mechanical restraint. In this country, restraint was considered necessary and was advocated even by men in positions of authority. In 1890, however, it was no longer claimed that patients in American asylums were more independent or unruly than the subjects of monarchies, or that the climate of this country, being more stimulating, led to greater degrees of excitement, as had formerly been asserted. By the end of the nineties, mechanical restraint had become a thing of the past or was used only in emergencies.

During this period, also, there was excessive use of hypnotics and narcotics, not only in the institutions but also in general medical practice. The days of venesection and tartar emetic were long past, but chloral, conium and bromides constituted a system of "chemical restraint." Hydrotherapy in the form of prolonged warm baths was in use; this was at first applied forcibly, tops being fastened over the bath tubs. We soon found, however, that force was not necessary.

During the period I am reviewing, the Board of Charities of Wisconsin developed a system of "County Asylums" unlike any to be found in other states, which were thriftily managed and subvented by the state treasury, which paid half the cost of maintenance. These institutions were exceptionally satisfactory, but were, after all, no exception to the rule that county boards of supervisors are suitable only for purely economic functions and not for the management of benevolent enterprises. The board gave their institutions the name of "semi-state asylums." In a paper on Outlines of State Care, read at Omaha in 1889, I expressed the opinion that semi-state care would eventually became "demi-semi" and ultimately "hemi-demi-semi" state care. Later developments have shown that, although such institutions can well meet the material needs, the lack of medical oversight results in absence of individual study and treatment. The medical care is provided by engaging a general practitioner who, as a rule, knows little of psychiatry and is apt to be chosen for his willingness to accept meager compensation for meager service.

The demoralization of the training school at Kankakee through political interference has already been mentioned. In the eighties when the Cook County Asylum at Dunning was under the infamous control of Mike McDonald and a board of county commissioners, some of whom were later sent to the penitentiary, Dr. James G. Kiernan and Dr. S. V. Clevenger tried to do something of a medical and scientific character at the institution. This brought them in conflict with the political ring. Dr. Clevenger reported some of the abuses to the medical profession and to the public; shortly afterward he was shot at while reading in his room. Dr. Kiernan, when suggesting improvement in the conduct of an attendant, was asked by the man if he thought he had sufficient "pull" to get him discharged and then beat Dr. Kiernan so badly that he was in bed for several days. (For some of the facts here presented I am indebted to "The Don Quixote of Medicine" written by Victor Robinson with the collaboration of Dr. Clevenger.) In the early nineties, when Governor Altgeld appointed the owner of a brewery and a saloon in Kankakee as a member of the board of trustees of the hospital, excursions were advertised by the railroad, and the mobs that patronized the brewery invaded the grounds of the hospital, creating scandals which Dr. Clevenger endeavored to obviate, without success, by instituting rules for admission to the grounds.

The medical and scientific work at Kankakee received great stimulus from the services of Dr. Adolf Meyer. I learned of him from Dr. Ludvig Hektoen, who had himself served for six months at Kankakee, just at the time when Dr. Clevenger became my successor, and advised his appointment as pathologist. Dr. Meyer served from 1893 to 1895; he inaugurated staff meetings and a course of instruction and improved the case-taking methods. Through his influence, also, the exhibit of the German government to the Chicago World's Fair with some valuable apparatus was secured for the state hospital. Late in the nineteenth century, developments occurred that led to the establishment of psychopathic hospitals. Griesinger had described the essentials of such an institution in 1868, and Dr. Pliny Earl, in 1867, said that a psychopathic hospital might be regarded as a probable future development. The first actual step in this direction was taken at Albany, N. Y., where, under the advice of Dr. J. Montgomery Mosher, a separate building was constructed for patients with mental diseases in 1902.

DISCUSSION

Dr. Bassoe: Dr. Dewey has modestly failed to speak of the many reforms he instituted. He spoke of the old forms of restraint, and his influence in restricting them was of great benefit to this part of the country. Formerly, state asylums were merely custodial. While he was at Kankakee, he began to have hospital service for the patients. It is almost impossible for us to conceive that the early institutions for the insane were considered merely places for detention. Another thing that made Kankakee famous through the Middle West was the idea of small cottages instead of the large institutional type of building that was used all over the country. Dr. Dewey and Mr. Wines, who was secretary of the State Board, formed the plan and built the small cottages where patients could be classified, and psychiatrists came from all over the country to see those small buildings.

Dr. Archibald Church: I am happy to go back to the work of my ever young friend. I landed in Elgin twelve years after Dr. Dewey, having gone into psychiatric work in 1884. The question of restraint at that time had

come up prominently, and a superintendent in Indiana had taken all his restraint cribs, muffs, straps, etc., made a huge pile of them and set them on fire with ceremonies witnessed by patients and public. One of my first duties at Elgin was to go through the house and determine how much restraint apparatus should be destroyed. I found that for a population of 500, thirty-five restraint cribs of the covered type had been provided; these were occupied almost entirely by demented patients who were likely to roll out of bed or distribute soiled matter about the room. I recommended that all but two of the cribs should be destroyed; they were not greatly missed. There was a violent difference between those who believed in physical restraint and those who employed chemical restraint, or drugs. In a similar manner I was directed to look over the night trays, as they were called, that contained about a hundred doses, chiefly bromides and chloral. These were administered nightly in some instances for many months and even years. They were ordered cut down to four doses. It was thought that there was more noise and confusion, but the institution got along better without the chemical restraint than with it. In this matter of restraint, as in so many others, it was found wise to pursue a middle ground.

When the political change to which Dr. Dewey referred occurred, I was appointed with others to wait on Governor Altgelt for the purpose of recommending that certain superintendents of state hospitals should be retained because of the good work they had done. We spoke of Dr. Dewey in a favorable sense, extolling his virtues and capacities, and were listened to rather impatiently by the Governor elect, who finally said: "What you tell me interests me, but what I want to know is what you can say against him that will justify his removal." The committee bowed themselves out.

The conditions at that time in connection with the institution at Dunning and at the County jail beggar description, and while they are outlined to a certain extent in the book to which Dr. Dewey has referred, the misuse of the insane is not revealed fully in any book I have ever encountered. The conditions which Pinel found and changed a half century before in France were perhaps nearer it than anything else.

Dr. H. I. Davis: I recall the tendency toward restraint at the old detention hospital. Dr. Church mentioned the trays with the doses of bromide that were sent to the wards each night, but I think that was a great improvement over what I found in the detention hospital in 1904. I saw the old "black bottle" containing 30 grains (1.9 Gm.) of bromide to the teaspoonful. The method of administration was simple. Any attendant could pour out as much as he thought necessary and let the patient drink it. Bromide makes patients thirsty, and the more thirsty they became the more bromide they were given —water was never offered. I do not think that the present psychopathic hospital is an ideal place for the care of the insane, but when I look back to the old detention hospital I think the present psychopathic hospital is an improvement. Straight jackets were plentiful, and many patients were never without them. My first request to have these destroyed and to have a little space where patients could be outdoors was looked on as preposterous. The changes that have occurred in the past twenty-three years have been remarkable.

Dr. A. B. Magnus: Will Dr. Dewey tell us how, with the wards extremely overcrowded, he would bring about the absence of restraint? Most state hospitals today are overcrowded, and the question arises: "Are we justified

in allowing such patients to injure or perhaps kill each other, or should we restrain them?" At the Boston Psychopathic Hospital, with less political interference than in this state, more attendants are used to eliminate restraint in some cases. In Illinois there is a shortage of attendants. It is well to carry on propaganda for doing away with restraint, but, in my opinion, this is of little practical value in present institutional conditions.

DR. DEWEY: The question of leaving two excited patients together in a room at night was a matter I often had to consider. In such instances one can generally form an opinion as to the likelihood of attack or assault. Patients who are liable to perform such acts usually are known and can be placed in a room either where they will be by themselves or where they will have close supervision from the night nurses or attendants. Night nurses and attendants are important in avoiding dangers of this type, and whenever two patients were placed in a room I invariably required that they should be patients of a harmless character from whom no real danger need be expected. If there was a larger number of this type, as there often was, many patients had to be kept together in a dormitory, and the night attendants were of much importance. The dangers incident to overcrowding are almost unavoidable. The mass of patients that has to be committed to institutions makes it impossible to provide these patients with the accommodations they should have.

THE RELATION OF PSYCHOANALYSIS TO PSYCHOPATHOLOGY AND PSYCHOTHERAPY. DR. MEYER SOLOMON.

The term psychoanalysis is used in three main senses: (1) for all causal psychotherapy and pedagogy, and all studies of psychogenesis of normal and abnormal mental states, especially personality study and reconstruction; (2) for the system of theoretical and applied psychology initiated by Freud and modified by himself or his followers, especially Jung and Adler; (3) for Freud's views alone. I shall use the term in the second sense. Psychoanalysis as thus interpreted includes: (1) a method of examination (mental exploration); (2) a method of interpretation of the data obtained; (3) a method for control of the mental processes to prevent and treat maladjustments and disordered mental states; (4) a system of psychologic theories applicable to normal and abnormal mental phenomena.

1. The method of examination by free association may be accepted as one of many of value in unearthing memories or fantasies which may or may not be of significance or causal relationship to the original conscious phenomenon under investigation. If it be claimed that data obtained by free association are useless it would be denied that one was practising psychoanalysis. Therefore, the attitude toward the method is more essential than the mere use of the method of free association. This depends on the "method of interpretation."

2. The method of interpretation is really free interpretation rather than a definite method. Data are gathered by free interpretation with the theoretically impossible object of investigating the patient's entire mental life, but the examiner stops where and when he wishes, selects what he wishes and interprets as he wishes. It depends on guesses, according to personal preferences, concerning the nature of supposedly hidden, psychologically repressed, unconscious complexes and wishes. The basis is a system of psychologic theories accepted as fact. The nonpsychoanalytic attitude is: try to interpet when possible, guesses to be admitted as such; furthermore, in the present state of knowledge, admit that many conditions cannot be explained satisfactorily; no special meaning, conscious or "unconscious," is always insisted on.

3. The method of control or treatment includes free association with the special interpretation of associations, dream interpretation of a certain special sort, and transference, which is a special interpretation of the patient's emotional reactions of like or dislike for the physician as being based on the resurrection of the patient's attitude in infancy toward the parents centered about the Oedipus complex (Freud) and will-to-power (Adler), or desire for rebirth (Jung). These are said to produce abreaction (confession), to resurrect buried memories, to make "the unconscious" conscious, to remove repressions and to overcome resistance. The nonpsychoanalytic attitude is: free association and dream interpretation may be used and are of value, but only in addition to all other methods; in place of transference one speaks of like and dislike, or attraction and repulsion—trust, faith, confidence, respect, admiration, dependence, hero-worship, love and their opposites, without insistence on any theories as to origin; resistance, repression, buried memories, whether of infantile or later origin, let alone of any special sort (sex or will-to-power), are not always presumed, although present in some cases; and no insistence on always tracing memories to infancy to find a hidden meaning.

Therefore, the psychoanalytic methods of examination, interpretation and treatment depend on an arbitrary system of psychologic theories accepted as fact.

4. The fundamental psychologic theories of psychoanalysis are general and special. The general theories are: (1) there is a special psychic energy; (2) mental experiences (wishes, thoughts, etc.) are conserved as such, lacking only consciousness; (3) a peculiar rigorous psychologic determinism — that all conscious phenomena are symbolic of a hidden meaning, actively existing in "the unconscious"; (4) a peculiar psychologic teleology — that there is a psychologic purpose to all mental phenomena, based on psychologic hedonism (avoidance of pain and gaining of pleasure); (5) there is a special psychologic dynamic agent (special kind of thoughts or wishes, sexual or will-to-power, in "the unconscious"). The nonpsychoanalytic attitude is: (1) there is no more special type of psychic energy than there is of liver, spleen, kidney or skin energy, but merely different forms of manifestation of the same fundamental energy; (2) mental experiences are not conserved as such; (3) although there is an efficient cause for all psychologic as other phenomena, there is no basis for the psychoanalytic conception of hidden, repressed, personal meanings; (4) psychologic phenomena may be purposive or nonpurposive, and psychologic hedonism applies to some but not to all states; (5) mental experiences are not always dynamic, and even when they are, the dynamic forces include any instincts, habits, emotions or sentiments.

The special theory is the conception of a particular type of unconscious mind: (1) which is supposed to be dynamic, psychologically repressed, hidden, psychologically purposive, unacceptable to and in conflict with the conscious personality, of infantile origin, and consisting of special sorts of wishes and ideas — sex, especially incest and perversion (Freud), will-to-power (Adler), rebirth or some psychologic type of functioning (Jung); (2) which has certain special methods of working (psychologic dynamics or mental mechanisms), especially "unconscious" mental conflict and "unconscious" psychologic repression, one element of the conflict always being "unconscious," the repressed and repressing forces being sex ego, inferiority-superiority, or opposite psychologic types of functioning (introversion-extroversion); a large number of other

mental mechanisms are presumed. The nonpsychoanalytic attitude is: (1) unconscious cerebral activities are accepted, but "the unconscious mind" is not; unconscious activities may or may not be dynamic, but are not necessarily psychologically repressed, or hidden, or psychologically purposive, or in conflict with consciousness or of infantile origin, let alone of special sorts of wishes; ideas and wishes are conscious experiences; (2) mental conflict and psychologic repression are accepted, but as conscious and not as unconscious; psychologic repression is not necessary for mental disorder; and the forces in the conflict include all instincts and wishes.

The main contributions of psychoanalysis are: its impetus to and popularization of the problems of a more dynamic and human psychology, sexual and mental hygiene, child study, personality study and reconstruction, and more careful history taking; its stressing the importance of mental conflicts centered about sex, inferiority-superiority, and psychologic types; and the principles of mental conflict and repression with self-rationalization and projection.

Conclusion.—Psychoanalysis as a special system of theoretical and applied psychology must be regarded as a parasitic growth in the field of scientific psychology, psychopathology and psychotherapy, which will absorb it, recognizing its contributions.

DISCUSSION

Dr. Mary G. Schroeder: Dr. Jung does not, as Freud does, emphasize sex, or, as Adler, "will-to-power," but says it may be an attempt on the part of the patient to escape some difficult task or retain a certain attitude. I think Jung's idea about repression is that if we make a voluntary choice it is not repression but self-control, but when there is repression we say we cannot have done that. It is when we refuse to face what we have done in a certain situation that repression comes in.

Dr. D. M. Olkon: Since Dr. Solomon has brought to us the sad news that psychoanalysis is dying or perhaps even dead, may we not offer our sympathy and in the memorable words of the thoughtful, good Roman say "de mortuis nil nisi bonum."

Dr. Solomon: Regarding Jung's views, I may say that many of the older neurologists and psychopathologists spoke of the neurotic as being childish and referred to present difficulties as important in causing neurotic behavior. For example, Dejerine in France and the older English writers have accepted this point of view for years. The fact that Jung is reemphasizing this idea does not mean that he is discovering something new.

As to "the unconscious," I did not say that there was no unconscious activity, but asked for the use of the term "unconscious mind," or "unconscious mental activity" in a definitely limited sense and not as applicable to the activity of the heart, liver and other organs, the ameba, etc. Psychology has been defined as the study of the conscious processes. Freud contends, and Jung agrees, that in the so-called unconscious mind there exist ideas and wishes of the same sort as exist in consciousness but of which we are not aware. This is incomprehensible to, or at any rate not accepted by, the rest of us. To accept this view means to regard the world as will and idea and admit that all living things not endowed with consciousness have unconscious minds (and not merely unconscious organized activities).

As to McDougall's ideas, I take the middle ground. Many conscious and unconscious activities have definite goals and others have not. When we speak of conflicts of a conscious nature, we are dealing with conflict of ideas, wishes and impulses — conative forces — but when speaking of ordinary physiologic activities, no matter how complex, of the organism, there is no need to insist on applying the hormic or dynamic concept. In fact, although many mental processes are dynamic, not all of them are.

Book Reviews

MUSCULAR CONTRACTION AND THE REFLEX CONTROL OF MOVEMENT. By J. F. FULTON, B.Sc., M.A., PH.D. Price, $10. Pp. 644. Baltimore: The Williams & Wilkins Company, 1926.

This is a clear, concise and scholarly book which fills a long felt need. It is dedicated to Sir Charles Sherrington, the author being one of his recent collaborators and pupils; the book reviews thoroughly the recent work on neuromuscular physiology, naturally dealing in a great measure with the investigations of Sherrington's school during the last twenty years. In fact, it may be said to have taken up the work where "The Integrative Action of the Nervous System" left it in 1906, and to have brought the subject up to date. Its importance to neurologists is therefore fundamental.

The historical introduction is interesting and brightly done. The rest of part I deals with basic physiology of the contractile response of skeletal muscle; this takes up 192 pages, and the list of chapter headings indicates the subject matter: (1) broad features of the electrical responses of skeletal muscle; excitation; chronaxie. (2) On the latent period of skeletal muscle. (3) The nature and course of the isometric twitch. (4) The summation of contractile responses in skeletal muscle. (5) Certain features of the mechanical responses of muscle to repetitive stimuli. (6) The innervation of individual muscle fibers in relation to fatigue. The problem of the neuromuscular junction. (7) The electrical responses of skeletal muscle during repetitive stimulation (tetani). (8) The significance of the action current of skeletal muscle.

At the end of each chapter is a good summary which enables the nontechnical reader easily to follow the main argument without reading all the evidence presented. Chapter 9 summarizes the present knowledge concerning the contractile process and at the end presents a brief working hypothesis in these words: "A wave of permeability with its attendant potential difference of characteristic duration passes down the motor nerve and leads to a hypolemmal concentration of ions in the region of the motor end-plate. This ionic concentration, either directly or mediately through some as yet unknown agent, causes a wave of permeability to sweep along individual muscle fibers. The morphologic path along which the excitatory wave travels in the muscle is at present unknown, but we are justified in believing that it lies in close structural contiguity with the sarcostyles. The ionic interchange resulting from the wave of excitation is responsible for the action current as well as for the liberation of lactic acid. Lactic acid apparently causes contraction, and it probably does so through hydrogenation of the regularly arranged surface molecules of the sarcostyle, the acid being presumably liberated within the sarcoplasm.

"When the length of the muscle fiber is altered, either before excitation or during contraction, the three phases of activity — the electrical, mechanical and thermal — undergo parallel modifications. With increased length the electrical, mechanical and thermal responses all increase, up to a certain point. This may be interpreted, according to Garner's hypothesis, as due to the diminished concentration of reacting bodies at the fiber membranes with the greater surface afforded by the increased length of the fibers. Various features of the mechanical response of skeletal muscle, such as the rate of development and the

shape of the curve of relaxation, the response to stretch, etc., are to be accounted for most readily by the conception that the contractile elements are possessed of high molecular 'viscosity,' and in the process of shortening they must of necessity overcome this frictional impediment. When a 'quantum' of lactic acid is liberated by a given stimulus, it surrounds the sensitive contractile interfaces, possibly as a monomolecular film, and when the concentration of acid ions sinks below a certain threshold value, an abrupt phase reversal appears to occur which leads to the sudden cessation of activity. This suggests itself as the cause of the 'angle' in the mechanical response. The shape of the ensuing curve of relaxation, according to this interpretation, is determined by the internal molecular 'viscous' forces of the muscle. Such in very rough outline is a tentative picture of the events accompanying contraction."

Part II devotes 272 pages to a discussion of "the nature of the integrative control exerted by the central nervous system upon skeletal muscle fibers in the performance of movements and in the maintenance of posture." Experimental methods are discussed and both mechanical and electrical records of muscular contraction are analyzed; fallacies are exposed which have led certain investigators to draw erroneous conclusions. In chapter 2, simple reflexes are discussed and the knee reflex in the decerebrate condition is contrasted with that in the spinal. Crossed extension reflexes and other somewhat more complex phenomena are similarly discussed in chapter 12. Two important chapters are devoted to inhibition. The evidence is presented on which the various theories are built, and the theories are then fully and clearly discussed. The author believes that Sherrington's chemical theory is at present the most adequate to explain the nature of the central inhibitory process, and also the excitatory process.

Reflexes in response to stretch, the "myotatic" reflexes recently described and studied by Sherrington and Liddell, are described in chapter 15. Since this work has great significance to clinical neurologists the author's summary is quoted:

"Stretch applied to the knee extensor of a decerebrate or thalamic preparation evokes active contraction of a reflex character. The receptors for the reflex lie in the fleshy region of the muscle and it is therefore a purely proprioceptive phenomenon. The reflex may be elicited by a stretch of less than 1 per cent of the total muscle length. Slow stretches, e. g., 5 mm. in 6 seconds, elicit the reflex as well as quick stretches though the size of the reflex is less with the abrupt stimulus. The latency of the reflex is of the same order as that of the knee-jerk, i. e., 6 to 9σ.

"The reflex is characterized by relatively complete absence of after-discharge the reflex disappearing immediately the stretch ceases. Other things being equal, the reflex continues to increase as the stretch increases. The reflex has been divided in two periods: (1) the phasic or kinetic period, which corresponds with the mechanical ascent of the reaction and is confined roughly to the period during which the muscle is being stretched, (2) the static or postural period during which active contraction is maintained after the stretch has ceased.

"The response to stretch in decerebrate preparations is intensely local, being confined to the muscle or portion of the muscle stretched. The smallest reflex unit is presumably a single stretch afferent with the surrounding group of muscle fibers which it controls.

"Proof that the reaction is a reflex comes from the fact that it may be completely inhibited by an appropriate ipsilateral stimulus, and also to the fact that the reaction disappears completely when the nerve is cut.

"The knee-jerk and patellar clonus appear to be fractional manifestations of the stretch reflex.

"Being confined to the antigravity muscles, the stretch reflex suggests itself as an important element in the reflex coordination of postural standing, as well as of stepping.

"There are at least three functionally different groups of sensory end-organs in muscle."

In the next chapter the mechanism and functional significance of muscle tone is reviewed. The recent polemics on the subject are fairly discussed and the evidence well presented. It is pointed out that the evidence for a contractile function of sarcoplasm rests entirely on inferences and analogies. The section on "Tonus and the Stretch Reflex" ably presents a reasonable explanation of the fundamental reflex mechanism which supports postural reactions. Orbeli's work is reviewed and supported, as giving evidence which explains the sympathetic innervation of skeletal muscle and harmonizes conflicting theories; his observations suggest that the sympathetic nerves influence the metabolic activity of muscle. There is no good evidence that these nerves directly influence muscle tonus. The "lengthening" and "shortening" reactions are then described as proprioceptive reflexes, the latter being a manifestation of the myotatic reflex.

Having now taken up the fundamental phenomena of excitation and inhibition, chapter 18 is devoted to reciprocal innervation: the coordination of antagonistic muscles. The classic examples of antagonism are described, and the objections to the law of reciprocal innervation are shown not to hold. Reciprocal innervation and synergic cocontraction are observed facts; they are not theories, and merely differ in degree of integration. Reflex stepping is the next subject and this naturally leads to a chapter on the anatomy and function of the cerebellum, a particularly valuable contribution, for it is discussed in the light of the physiology of Sherrington and Magnus. Briefly, the cerebellum is an organ which facilitates accurate and delicate adjustment of complex movements, i. e., its function is synergia.

The last chapter is concerned with the nature of higher control and takes up the influence of the higher centers of the nervous system on tonic reactions and the way in which voluntary contraction is superimposed on postural contraction. An admirable synthesis is made of the views of Bell, Jackson and Head. To these the author adds Sherrington's "final common path" and his own theory of "long circuiting"—the process of deflection of impulses up the cord to the higher centers. Thus the usually accepted, but inadequate, explanation of release of function by "removal of inhibition" is expanded into a satisfactory hypothesis. Two diagrams are given illustrating the nature of a synaptic mechanism which will account for the cooperative interaction between cortical and tonic (i. e., myotatic) contraction, and other important features of reflex physiology. This schema includes the author's idea of "long circuiting" and calls only on well established morphologic conceptions, attaching especial significance to the fact that the pyramidal tracts do not all terminate directly on neurons of the final common path, for many embouch on the internuncial neurons. Thus both excitation and inhibition are explainable, and a basis is given for the comprehension of the harmonious coalescence of voluntary and tonic contraction. This is probably the most important chapter in the book, and one wishes it had been expanded and elaborated.

The technic of myography is described in an appendix. A fine bibliography of 1,066 titles is appended, with an admirable index of authors indicating

both when an author is quoted and the source of the quotation. There is also an exhaustive index of subjects. If all writers on scientific subjects would follow Fulton's example of clear presentation of evidence, meticulous reference to source, and able summarizing at the end of each chapter, the reading of monographs would become a pleasure.

DIE PSYCHISCHEN HEILMETHODEN. By KARL BIRNBAUM, OF BERLIN, IN COLLABORATION WITH H. V. HATTINGBERG, G. R. HEYER, E. JOLOWICZ, A. KRONFELD and E. WEXBERG. Price, M, 18; bound, 21. Pp. 462. Leipzig: Georg Thieme. 1927.

As is true of all German textbooks, the material in this work is presented in an orderly manner, but, in spite of the author's statement that complicated methods and descriptions are to be omitted, a tendency to unnecessary detail remains. Part I, by Birnbaum, takes up the theory of psychotherapy and of psychotherapeutic technic. Thirty references are given in this introduction. Part II, consisting of about forty pages, by Jolowicz of Leipzig, is a treatise on the various phases and therapeutic value of suggestion. The physician who is interested in the treatment of psychoneuroses will find much of value in these pages, as the author confines himself well to what might be considered rational therapy. Part III, by Heyer of München, discusses hypnotism. Many references are given. This chapter, except to those who are especially interested in hypnotism, becomes rather tedious and is probably of the least value from the standpoint of the general practitioner, for whom the book is intended.

In part IV, the subject of psychoanalysis is ably discussed by von Hattingberg. There is little that is new in this chapter. The author adheres closely to the freudian school. Part V is a closely allied chapter, by Wexberg, on individual psychologic treatment and is extremely interesting. The author takes up the individual's entire environment and attempts to analyze, in a rational manner, the exact situation in the patient according to his makeup. Part IV, by Arthur Kronfeld of Berlin, deals with the pedagogy of psychotherapy and brings the book to a proper close. Kronfeld gives a splendid historical sketch of the evolution of psychotherapy from earliest times. In discussing the psychotherapeutics of abnormal children he lays special emphasis on the close and orderly working of the physician with the guardian. While much of a philosophic character is included in this chapter, the entire subject of psychotherapy from the pedagogic standpoint is admirably presented.

The book is well written in print that is more readable than many of the German textbooks. It covers 462 pages with a bibliography at the end of each chapter. The subjects are well covered, and the book deserves recommendation for both study and reference.

THE SIGNIFICANCE OF THE PHYSICAL CONSTITUTION IN MENTAL DISEASE. By F. I. WERTHEIMER and FLORENCE E. HESKETH. Johns Hopkins Hospital. Medicine Monograph. Volume 100. Price, $2.50. Pp. 87. Baltimore: The Williams & Wilkins Company, 1926.

Writers who would formulate and codify, usually begin by tearing down existing classifications, showing the uselessness of the procedure as a whole, then analyze their material and erect a system of their own, which is often no better than the systems they have derided. Finally, they reach out into the realms of classics, poetry, religion, music and art for verification. The authors of this little book run true to type, and their only deviation from the standard

is the unusually small material they have to work with, consisting of only sixty-five persons. To be sure, these persons were studied in detail; for example, fifty-three direct measurements were made and thirty-seven different indexes were calculated. With their frequency distribution curves, however, they cannot expect to bring out small variations indicating bimodal or trimodal curves. The probable errors in the selection of persons must be extremely high.

On the subject of indexes, they show clearly that the weight of a person should not be considered in evaluating the morphologic habitus, since the weight fluctuates so greatly, and their new anthropometric index comprises only definite linear measurements.

$$\text{The Index} = \frac{\text{Leg length} \times 10^3}{\text{Transverse chest diameter} \times \text{sagittal chest diameter} \times \text{trunk height}} \times 100$$

This index separates the pyknic from the asthenic build, as almost any index would do, and it shows a large number of persons designated "pyknoid," "unclear," "athletic," "asthenic-athletic," and "mixed" connecting the two extremes. In correlating the form of the body with the phenomena of the behavior of these mental patients, the clear schizophrenic cases fall, as would be expected, mostly in the asthenic and athletic group; whereas, the cyclothymic types predominate in the pyknic and pyknoid group.

The authors' final offense is to divide all men into idiotropic and syntropic personalities and to reprint a wood-cut of Mr. Pickwick, "illustrating the pyknic habitus in a syntropic personality."

LE PEYOTL (ECHINOCACTUS WILLIAMSII). By A. ROUHIER. Price, 35 francs. Pp. 384. Paris: Gaston Doin et Cie, 1927.

The object of this book is to bring to the notice of the medical profession the scientific uses and therapeutic value of the *Peyotl*, a species of cactus found in the plateaux of Mexico. The first part of the book is devoted to the geographic and botanic origin of the plant in considerable detail. Then follows a history of the tremendous importance of this plant in the lives of various Indian tribes, its sacred significance, legends and its many medicinal and curative uses. It is, however, the latter half of the book that is likely to prove of interest to neurologists. After describing at length the clinical value of the plant, the mode of extraction of its six alkaloids and their reactions, its pharmaceutic value is discussed with the different preparations of the drug and dosages. Next the physiologic action of the drug is considered, stress being laid on its advantageous comparison with opium, morphine and other drugs now commonly in use, because of its slight toxicity, nonhabit forming properties and absence of disagreeable after-effects. A number of experimental and case reports are given in which the subjects (among others, those of S. Weir Mitchell and Havelock Ellis) describe at length their bizarre psychophysiologic experiences while under the influence of this drug and its marvelous effect on the central visual centers; the author suggests its use as an aid to psychoanalysis and a nearer approach to the subconscious. The medicinal value is next discussed, its power of stimulation of the entire nervous system, the freedom from fatigue experienced by those who have eaten of the plant, and its remarkable healing properties in various diseases and poisons. The author believes there is a vast field of possibilities in the use of this drug, at present little realized by the medical world in general.

Ataxies Aigues: L'ataxie Aigue Tabetique. By Jacques DeCourt. Price, 18 francs. Pp. 150. Paris: Gaston Doin et Cie, 1927.

DeCourt calls attention to a striking mode of onset in tabes when it develops overnight or even in an apoplectiform manner. The study is based on seven personal cases and a dozen or so collected from the literature. In most instances the acute onset of the ataxia was coincident with an exacerbation of a preexisting, but unrecognized, tabes dorsalis; it was indicated not only by the symptoms and signs, but also by the serologic changes in the cerebrospinal fluid. These cases for the most part ran an unusually benign course under active antisyphilitic treatment; except for Argyll Robertson pupils and reduction or loss of tendon reflexes the tabetic signs cleared surprisingly.

As the author remarks, it is curious that the larger textbooks on medicine and neurology have paid little attention to this form of onset of tabes. Contrasting the acute ataxias due to tabes, DeCourt also considers the acute ataxias due either to polyneuritis or to that curious acute disease described by Leyden, about which the author admits that knowledge is still far from complete. He reports in detail one case of each type. The differentiation between these various diseases leading to acute ataxia is based on ascertaining the etiology and by study of the cerebrospinal fluid, for all tend to follow the same benign course.

Technique Histo-Bacteriologique Oculaire. By Y. D'Autrevaux. Price, 31 francs. Pp. 157, with 24 illustrations. Paris: Gaston Doin et Cie, 1927.

The field of ophthalmic pathology is so specialized that most treatises on pathologic technic deal cursorily with it; yet unless certain procedures are carried out with care, a preparation results that is practically useless for finer study. D'Autrevaux, Director of Laboratories of the Quinze-Vingts, has collected all the directions for a complete study of diseases of the eye, from removal of specimens at biopsy to the microchemistry of the aqueous humor. Certain references are given in the text to work of various investigators, but more might easily have been added, for in carrying out some of the more complicated technical procedures, the pitfalls and corrections can be learned best from the author who has developed the method, and in that case the original communication must be consulted. Fortunately, the illustrations are small and of the type seen in textbooks on technic during the nineties; the introduction of Morax is an appreciation of the work of the author.

A Textbook of Clinical Neurology. By Israel S. Wechsler, M.D. Price, $7. Pp. 725. Philadelphia: W. B. Saunders Company, 1927.

This book is an excellent presentation of the modern point of view of neurology. It is a little larger than the average manual, but the description is necessarily curtailed, as would be expected in a textbook which covers neurology in so few pages. The arrangement follows classic lines. The methods of examination include psychometric tests by the author's brother, Dr. David Wechsler. Then follow, in order, descriptions of diseases of the spinal cord, the peripheral nerves and the brain. The neuroses which follow are covered in sixty pages. No attempt is made to include all the endocrine disorders. The book is essentially a sane, modern presentation which can be recommended to the student.

TRAVAUX ET MEMOIRES. By PROFESSOR PIERRE MARIE. Volume 1. Price, 30 francs plus tax. Pp. 355. Paris: Masson et Cie, 1926.

Pierre Marie has rendered a service to neurology in collecting and republishing certain of his published works so as to make them available to the present day neurologist. These papers are republished as they originally appeared, the only alterations consisting in replacement of some of the original cuts and illustrations which were no longer available. The choice of the subjects is arbitrary and consists of two parts, the first including fifteen papers, all of which are devoted to Marie's epoch-making views on aphasia. The second part is largely clinical. There are three papers on acromegaly, one on syringomyelia, and the rest are on various phases of arthropathy, with an extensive discussion of spondylose rhizomelique.

CROONIAN LECTURES ON THE EVOLUTION AND DISSOLUTION OF THE NERVOUS SYSTEM (1884). By J. HUGHLINGS JACKSON. Translated by Otto Sittig. Pp. 137. Price, M. 6.60. Berlin: S. Karger, 1927.

Any neurologist who calls attention to Hughlings Jackson's lectures on the evolution and dissolution of the nervous system renders a distinct service. Some years ago, Otto Sittig translated Jackson's study of convulsions. In the present volume there is given an accurate reproduction of Jackson's lecture as it appeared in the *Lancet*, on one side of the page with a translation into the German on the other. It would be highly desirable if all students and neurologists were to keep a copy of this book on their desks, for the philosophy of neurology, as it is expressed in these lectures, has never been equaled.

THE ARCHIVES OF NEUROLOGY AND PSYCHIATRY is published by the American Medical Association to stimulate research in the field of diseases and disorders of the nervous system, and to disseminate knowledge in this department of medicine.

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The ARCHIVES OF NEUROLOGY AND PSYCHIATRY is published monthly. Annual subscription price (two volumes): Domestic, $8.00; Canadian, $8.40; foreign, $8.75, including postage. Single copies, 85 cents, postpaid.

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